ANIMAL·LIFE UNDER·WATER

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D Fletcher.
from "Margaret" Young
Xmas - 1919.

ANIMAL LIFE UNDER WATER

Common Brown Trout (*Salmo fario*) reflecting its surroundings.

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With 5 Colour and 48 Half-tone Plates

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Contents

List of Plates

LIST OF PLATES

Animal Life Under Water

CHAPTER I

BY WAY OF INTRODUCTION

AN account of the habits of a fish-eating bird or animal cannot be considered complete unless the aspect of the bird or animal is described *as seen from below the surface of the water*, that is to say, from the fish's point of view. Under-water appearances differ so greatly from the usual conception that it will be necessary first to explain the general principles of an under-water scene.

This explanation given, I will next record my reasons for thinking that man's under-water point of view is similar to that of the fish; if the reader agrees with me on these points, we shall be on common ground, and I can then proceed to show how under-water appearances affect the habits of subaqueous life.

Imagine yourself, then, under the water, on the bed of a river. Seen from below, the surface of the water would appear as an extensive mirror, with the river-bed reflected upon it. Immediately above the observer the reflecting surface is broken by a circular hole or window. Through the surface of the water, in the area of this "window," the sky and objects immediately overhead have their usual appearance, but in addition surrounding objects above the water level are also seen through the "window" as dwarfed and distorted images, suspended, as it were, in the air above the circumference of the circular hole.

A ring of iridescent colours separates the "window" from the surrounding reflecting surface.

The foregoing will be made plain by an examination of the illustrations on the following three plates.

On the folding plate are two scenes; the top one represents a view on a barren Highland loch. One arm of this sheet of water has been cut across, and the water and the bed of the loch are seen in section. Imagine your eye to be at the point C; the line A B represents the diameter

of the circular "window" immediately above the observer.

Let us first consider the white gull flying overhead, the large round boulder on the bottom, to the right, and the submerged water-lily leaves beyond.

From the point C the gull appears as shown on the lower illustration; that is, as a dark silhouette flying across the "window," with the fleecy clouds beyond. The gull swimming on the surface and the penguin and fish under the water will be referred to later. Outside the circle the surface of the water reflects the dark bed of the loch, but the reflected images of the round boulder and water-lily leaves are alone illustrated. Now look again at the top illustration. A gull is shown swimming on the surface beyond the circle; a sailing boat is seen coming down the loch, and at the water's edge a fisherman awaits the arrival of the boat. Seen from below the water, that portion of the gull beneath the surface is seen as a dark object on the left, marked by a white cross, while the image of the head appears on the edge of the circular "window." The hull of the boat cannot be seen under the water, for it is lost in the dark

distance, but the stunted sail, as it blends with the hills beyond, is seen in a similar manner to the gull's head. The rugged bluff on the right towers overhead, while the distorted features of the fisherman look down upon the observer as if from a gallery. In this manner the whole of the surrounding objects and scenery are crowded into a cone, the vertical angle of which—A C B—is one of ninety-seven degrees.

Let us now consider the illustrations on the next plate. These are photographs of the lesser black-backed gull, a penguin and a rainbow trout as they would appear if seen from the point C in their positions as shown on the folding plate. In the top photograph only that portion of the gull below the surface is visible. This submerged portion has the appearance of a bipalatinoid with four feet attached at one end. The bottom half is the bird, while the top half is merely reflection from the surface of the water. The white streak across the centre marks where the body of the gull cuts the surface, and it will also be seen that the portion of the white bird which is below the water reflects the colour below, as does the surface of the water.

The penguin in the second illustration is

entirely submerged, and the whole of it is visible against the surface of the water, while the trout has the large boulder as a background.

I have now described the appearance of objects both near and distant, above, on and below the surface. Only one more position remains to be considered, namely, when the lower portion of the object is on the bottom—on a level with the submerged observer—and the upper portion is above the surface. This is illustrated by a wading angler on the plate opposite.

Y is the point of observation, X Z the diameter of the "window," Z W the reflecting surface of the water beyond the "window." How the wading angler appears to the observer from the point Y is shown in the lower half of the plate. In the foreground are the rocks on the bottom of the stream, with subaquatic vegetation attached to a boulder on the right, then the legs of the angler encased in brogues and waders, and above this a streak of light, where his thighs break the surface. The remainder of the image up to the arc of the circle at Z^1 is merely reflection.

Above the arc of the circular "window" are

seen the compressed head and shoulders and the distorted features of the angler who appears to be looking down upon the observer over the edge.

The point z^1 on the arc of the circle in the lower illustration corresponds to the point z in the upper part, and the reflecting surface z^1 to w^1 to the surface between z and w.

A subaquatic view differs from terrestrial scene in that the foreground is always well lighted—*provided the scene is not too deep under the water*—while outside the range of this light the bed of the pond or river appears darker and darker, until the reality and the reflection blend in the gloomy distance.

A perfect reflection from the surface of the water is only obtained *when that surface is unbroken.* The appearance of objects, as seen from below, when the surface of the water is disturbed will be referred to later.

The size of the "window" varies with the position of the observer; roughly, the radius of the circle corresponds to the depth of the point of observation, below the surface. With the eye three feet below the water the circumference of the hole would be approximately eighteen

feet. If the observer sank to a depth of nine feet, the circumference of the "window" would increase to fifty-four feet, and, again, diminish as he came nearer to the surface until it disappeared altogether. It will be shown how this optical fact enables fish and birds to escape detection from their enemies under the water, as they slip out of the "window," where they are conspicuous as silhouettes against the sky.

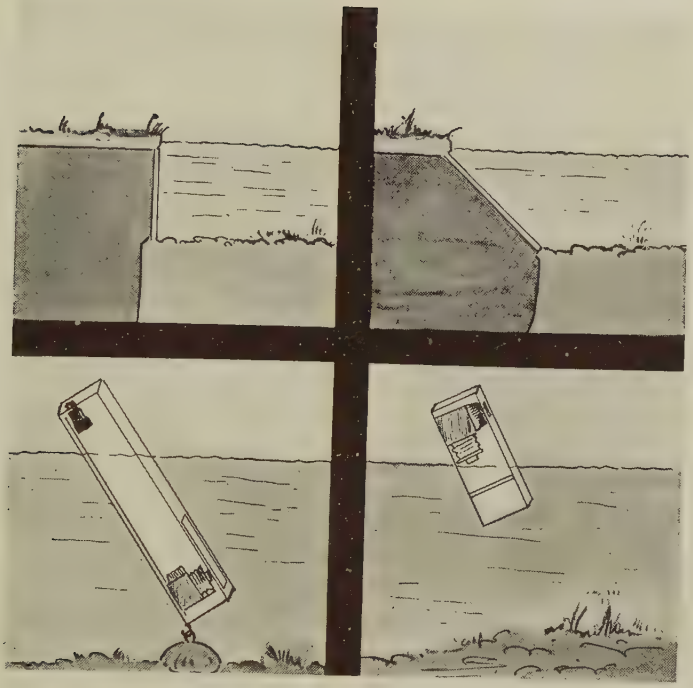
Many of my readers are doubtless familiar with these phenomena, dependent as they are upon optical laws which govern the course of rays of light from air into water, but I have described them at some length for the benefit of those who may be considering the underwater point of view for the first time.

In the spring number of *The Field*, May 4th, 1912, I published an article on "The Angler from the Fish's Point of View." Consequent upon some statements made, Mr. Cecil Hawkins drew my attention to some errors that are likely to arise in estimating the real position of an object, when viewed from under the water through a plate-glass window, owing to the rays of light from the object under consideration being refracted as they passed through the glass.

In consequence of his helpful criticisms all the subaqueous observations and photographs in this book were made under such circumstances that the rays of light from the object observed struck the glass of the observation chamber or apparatus *at right angles;* refraction and consequent distortion have thus been reduced to a negligible quantity.

A description of my first observation pond was given in " Marvels of Fish Life," published by Cassell's in 1911. This consisted of a concrete pond with an observation chamber below the level of the water in one bank of the pond. No light entered this chamber except through the surface of the water. Life in the pond was therefore observed illuminated as in Nature. Further, in consequence of the light in the pond and the darkness in the chamber, the glass became a mirror to a fish, and the observer, if clad in dark clothes, was entirely invisible to the denizens of the pond.

The observations and illustrations in this book have been made from ponds built on the same principle, but, as I have stated, the glass windows of the observation chambers have been fixed at various angles so as to avoid distortion.



Methods of Subaqueous Observation.

Observation Tank in the bank of a controlled stream.

My observations have also been checked by means of a swinging apparatus, with a mirror at the bottom, which served as a periscope under the water.

Finally, a box apparatus has proved useful as a telescope for direct downward observation.

These different forms of observation are diagramatically shown on the accompanying plate.

For the observation of objects in the water a vertical glass is used, as shown in No. 1; while for recording the appearance of objects on and above the surface the "window" is fixed at various angles as shown in 2. In 3 and 4 two forms of box cameras are illustrated for underwater photography, with the photographer above the level of the water. A temporary box observation chamber is shown on the lower illustration on this plate. This box when in use was, of course, covered by a lid. It will be seen that the supply of water into the observation stream was controlled through a pipe.

I would next draw attention to the value of *reflection* as a concealing factor under the water. In Chapter III of "Marvels of Fish Life" I dealt fully with this subject, and showed how this reflection was modified by counter-shading and

markings on the body of the fish. On the present occasion I take the opportunity of showing rather an exceptional colour photograph of the common brown trout. I hardly think it is realised that such a highly pigmented fish as the brown trout reflects to the extent shown in the illustration. *Concealment by reflection* among fishes is to a great extent due to the presence of iridocytes in the skin of the fish.

Under certain conditions many forms of subaquatic life are equally well protected by reflection from the fact that they are *white*.

The reflecting power of a white object under the water is shown by an experiment illustrated on the colour plate opposite.

An observation pond was allowed to become overgrown with confervæ. The pond was emptied and the green growth removed from the plate glass of the observation chamber; a stick, with squares of white cardboard attached, was then stuck in the empty pond. The cards were slightly tilted towards the bed of the pond. Seen thus, the surface of the outside card retained its whiteness, but as soon as clear water was run into the pond this white card *reflected the green bottom* as shown. In this experiment

White Cardboard reflecting Green Coloration in a Pond.

three cards were nailed to the stick to give more substance, and it will be seen that the top of each card shows white as it catches the light from above.

How do the white forms of animal life deal with this revealing reflection of top light? *By invariably taking up a position where the top light is cut off.*

This is well illustrated in the accompanying colour photograph of the white anemone (*Actinoloba dianthus*). The top illustration shows this anemone just commencing to open. For this photograph the anemone was placed in an unnatural position to illustrate how conspicuous it was when reflecting top light. In the middle photograph the same anemone, shown closed, has moved on to the side of a stone under the shelter of a shelving rock. The top light was now cut off, and the white anemone reflected its surroundings and appeared green.

Even in the event of the top light not being completely cut off, a white object is often concealed by partial reflection of the surroundings. For example, in the bottom illustration the same anemone is shown attached to a block of granite. The stem of the anemone is catching the light

from above, while the half-open portion is reflecting the reddish-yellow colour around, and so appears to blend with the granite rock.

White objects on the surface are also concealed by reflection. The top illustration on the plate opposite page 4 shows how the body of the lesser black-backed gull reflects the colour below and is, in consequence, inconspicuous against the surface of the water.

But it is not necessary that the plumage of a bird should be white for it to secure concealment by reflection, for *black-plumaged birds become mirrors under the water* owing to reflection from the air bubbles retained in their plumage.

Opposite are two illustrations of the same water-hen. The bird is shown swimming on the surface in the area of total reflection. The lower half of the bipalatinoid-shaped object, as already explained in the case of the gull, is the body of the bird below the surface of the water. The upper half is merely reflection.

In the top photograph the light streak where the body of the bird cuts the surface is well marked. In the lower illustration the streak of light between the reality and reflection is not so

Two Views of the same water-hen swimming in the area of total reflection.

obvious; here, however, the body of the water-hen under the water is dark green in colour, while the reflection is of a lighter shade. The explanation as to why the water-hen appeared first red and then green is as follows: I placed in the pond immediately in front of the glass a large sheet of tin, painted red. In the centre of this tin I cut a small hole through which I photographed the bird on a Lumière colour plate. Next I took the same bird to a pond overgrown with confervæ and green vegetation. The portion of the black-plumaged bird below the surface now appeared green by reflection, as shown in the lower illustration.

It must be realised that the foregoing remarks only apply when the anemone, gull or water-hen are viewed *from under the water*. The white anemone seen in the sea from a boat may appear white, even if under a shelving rock, because it reflects the rays of light from the point of view of the observer. But to the observer under the water, on a level with the anemone and with the top light cut off, it appears green, red or any other colour that may be reflected from its surroundings.

In the same manner, if from the bank of a

stream a water-hen is seen to dive into the water, the bird appears a mass of silver, for the air bubbles in the feathers reflect the light from above. I have shown how, seen from below in the area of total reflection, this bird is concealed by reflection.

Though a white object on the surface, seen in the area of total reflection, is concealed, this very reflection causes it to become conspicuous as soon as it is seen in the area of the circular "window."

Examine the plate opposite. On a pond specially constructed for surface observation a white saucer was floated down on the water towards the observer. Seen from the chamber, the surface of the water reflected the green undergrowth in the pond; *the saucer did the same, and was, therefore, lost to view.* The position of the saucer in the area of total reflection can be detected by the white ring where the saucer cuts the surface.

As soon as the saucer floated into the circle it will be seen how prominent it appeared, for it continued to reflect the green undergrowth and is seen as a dark silhouette against the light of the sky.

A White Saucer floating on the surface of the water seen from below, in the area of total reflection and in the "window."

(Hold this Plate at an angle of 45° at the level of the eyes.)

The same occurs with bird life on the surface.

The concealment of a bird on the surface is probably both protective and aggressive.

The young water-hen only becomes obvious when it swims into the pike's "window," but before the fish is ready to attack the bird has again disappeared into the area of total reflection. Again, if a sprat is swimming, say, a foot under the water, the arc of his "window" is only a foot in front of him, and the surface-feeding gull can be almost over him before the fish detects his enemy.

It might be thought that the white streak where the body of the bird cuts the water would reveal the gull, but this is not so, for the slightest ripple on the surface causes flickers of white light among which the streak is lost.

Although reflection is undoubtedly the main factor in the concealment of subaquatic life, mimicry, pure and simple, also plays an important part.

Not only do many fishes, crustaceans, anemones, &c., mimic vegetation perfectly, but various marine organisms are pigmented so as

to resemble colour reflected from marine vegetation.

Several red and brown seaweeds seen by transmitted light appear red or brown, but when seen against a dark background at various points they reflect a brilliant bluish colour. One of the plants to show this best is *chondrus*. In certain positions the whole side of rock covered with this seaweed flashes blotches and streaks of bluish-purple light.

Many forms of marine life which usually inhabit rocky seaweed-covered areas show bluish-purple markings, e.g. lobsters and crabs. The swimming crab (*Portunus puber*) shows this particularly well, and in pools on the Cornish coast I have frequently found a small brown anemone with purple markings exactly the colour of the purple light reflected from *chondrus*.

The next point to be considered is "*Flash*." When a reflecting body in the water turns so as to catch the light from above, there is a flash of white light.

These flashes of light from the bodies of fish, birds and lures have such an important bearing on feeding habits under the water that I must deal with "flash" in some detail.

As a fish swims in the water the sides and the under parts of the fish reflect the general colour and shade of its surroundings, while the amount of light reflected from the back of the fish is regulated by the relaxation or contraction of the dark pigment cells in the skin of the back. A fish is therefore a swimming mirror, and so long as it swims on a level keel it is inconspicuous wherever it goes.

If, in turning, the fish goes over ever so slightly on to one side, the opposite side catches the light from above, and there is a *momentary flash*.

Next, a fish maintains its balance in the water by a concerted movement of its paired fins. When a fish becomes diseased or weak, this perfect balance is interfered with, and as the fish swims it rolls on to one side, and only rights itself with an effort. These movements result in a *protracted flash*. The track of this weak fish, as it proceeds on its wobbly course, is marked by a series of *intermittent protracted flashes*.

Later I will show how intermittent protracted flashes of light are emitted from the plumage of divers under the water, and are

probably the means of attracting fish towards them. I will also illustrate the value of "flash" in all our fishing lures, such as spoons, salmon-flies, and wet trout flies.

A reference to the frontispiece will show how perfectly the pigmented brown trout reflects its surroundings.

I now show the same brown trout feeding, and it will be seen to what extent this fish flashes as it turns to pick up a worm.

This trout had a stance opposite the "window" of an observation chamber, and here he would hang motionless, except for an almost imperceptible movement of the paired fins and an occasional lateral swish of the tail to keep him up in the stream. Earthworms were dropped into the water above this fish, and as they were carried down to him he turned and picked them up, with the resulting "flash" shown in the lower photograph.

As a boy, during the hot, dry summer holidays, I frequently fished the running worm in Scottish rivers and Highland burns. It used to strike me then how difficult it was to see the trout even in the clear low water. I did not appreciate the value of counter-shading, reflec-

Brown Trout waiting for Food.

The "flash" as the Trout turns to pick up a worm,

tion and protective markings, but I knew what the "flash" meant. Keep your eye on the spot to which you think your running worm is being carried; a quick, almost imperceptible, "flash" —strike, and you have him.

Adherence to this principle has often helped to fill a creel.

Until one has seen it, it is difficult to realise to what extent various forms of animal life "flash" under the water. For example, light is flashed from the glossy lustre of the cormorant's plumage, while other divers depend upon special white markings for this result. On the top illustration of the plate facing page 20 a cormorant is shown with a herring in its bill. The cormorant's black head is flashing silvery-white, while the silvery herring is black.

In the lower illustration a fish is flashing as it evades the attentions of a seal.

In conclusion it may fairly be asked whether the observations made by the human eye are any indication of what the fish sees. In structure the eye of a fish differs very little from the human eye, except that the cornea is flattened, with the result that the fish is short-sighted compared with man. But I have not the slightest

doubt that the same colour schemes and markings that conceal life under the water from man conceal it also from fish. In support of this statement I must explain that when I first started to watch the habits of fish in observation ponds, one particular species was examined at a time. A month or more before these were introduced into the pond it was prepared so as to resemble the usual habitat of the particular fish to be observed, not only as to water supply and vegetation, but also with regard to its natural food. When I decided to examine the brown trout, gravel, stones and rocks were arranged on the bottom of the concrete pond. A watercress bed was planted at the shallow end where the water flowed in, and the pond was stocked from an adjacent stream with fresh-water shrimps, snails, caddis, stone loach and minnows.

When the balance of life was established and the shrimps were breeding freely, a wild trout from the same stream was added to the pond.

A constant stream of water ran through the observation pond, and the clear space in front of the observation chamber was virtually a pool in a trout stream.

When visitors descended into the chamber

Cormorant with Herring.

A Flashing Fish.
(From Cinematograph Film.)

they invariably wished to see the fish feed. I usually netted out a few stone loach in the shallow water and threw them in above the trout.

As the loach swam down it was very conspicuous, but as soon as it reached the bottom it melted from sight.

In a similar manner the trout could see the loach in the water, and would make a rush at it from behind a stone or from the other side of the pond; if, however, the little fish got to the bottom before the trout seized him it was safe.

The trout would swim round and turn down his eyeballs, but, so long as the loach kept still, the same colour scheme and markings which concealed it from the human eye concealed it from the trout.

Again, for some months I watched pike. One fish, some three pounds in weight, used to lie on the bottom, within six inches of the glass of the chamber. Four feet farther into the pond a patch of rushes had been planted, and roach, rudd and dace—the natural food of the pike—moved about in the water. I have seen two or three dace slowly move up in front of the rushes and then hang in the water; when a particle of food was carried down in the stream a dace

would give a quick turn to seize it, and there was a momentary "flash." If the pike was on the feed he would show his agitation at once by a glint of the eye and by erecting his dorsal fin, but by no other movement would the predatory fish show that he had detected the presence of his prey. A second "flash," and the pike raised himself on his paired fins, straightened his back, and, rigid with excitement, slowly glided towards the patch. If the dace remained until the pike was within striking distance, there was a sudden rush, a swirl, and the small fish was seized by the middle, turned and swallowed.

The pike was on the look-out for food, yet the same reflection of colour and counter-shading which made it difficult for the human eye to detect the dace concealed it from the pike, and the same momentary "flash" which was apparent to the human eye was an indication to the pike of the presence of its prey.

Whether fish appreciate colour in the same way as we do has always been a rife subject for discussion.

I argue that a great many forms of fish food are concealed from the human eye by colour schemes; the same food is undoubtedly con-

cealed from the fish. The structure of the eye of a fish suggests that it ought to be able to appreciate colour, and therefore it seems only reasonable to think that fish appreciate colour values.

" Jim Jam " described in *The Field* a series of feeding experiments by which he showed that a roach could appreciate red, white and blue as colours. And dry fly-fishing certainly leads one to think that a fish is not colour blind.

The question of the " window " and the area of total reflection depends upon definite optical laws which control the course of rays of light from air into water. With the fish's eye very similar in structure to the human eye, there is no reason to think that the fish sees the world above the water in a different manner from ourselves.

It has been experimentally proved that the trout see a very large arc of the circular " window " as he lies in the water; in fact, all of it except for sixty degrees immediately behind him. This is quite easy to believe when one thinks of the behaviour of the surface-feeding fish.

Keep immediately below him, and as long as you throw your fly straight above the fish he will

come up and look at it or some other pattern as long as you like to continue this form of exercise. But drop your fly to one side; the trout does a half-turn and swims towards it. You are now no longer immediately behind the trout, and you come into that portion of the arc of the "window" which is visible to the trout; he sees your distorted features above him, and is off like a dart.

CHAPTER II

THE CORMORANT AND OTHER DIVERS

IT has been necessary to write a somewhat lengthy explanatory chapter so as to make clear certain points in natural history as seen from under the water.

I now propose to describe the life history of a few birds and animals without further detailed reference to these points, on the presumption that the reader has grasped their significance from the introductory chapter.

The name "divers" has been given by the naturalist to certain sea-birds that either swim or fly after their prey *under the water.*

The British divers include the grebes, the northern, black and red-throated divers, guillemots, razorbills, puffins and cormorants.

The main diet of sea-birds consists of fish; divers feed on fish almost exclusively, while gulls take fish to a far greater extent than is generally recognised.

As an example of the ways of divers, let us consider the cormorant, though, as a matter of fact, this bird does not dive at all! When it leaves a rock it flies on to the water, alighting on the surface with a splash; it then disappears below the surface and *swims* after its prey. By means of its webbed feet alone it propels itself through the water, in this respect differing from the penguins, who use their modified wings for this purpose.

Thirty-six species of cormorants are known, but only two of them frequent the British Isles —the common black cormorant (*Phalacrocorax carbo*) and the green cormorant (*Phalacrocorax graculus*).

Both species are found together round our shores, but the green cormorant, or shag, is not often seen east of the Isle of Wight, and is uncommon round the coast as far up as Caithness. Both are found in about equal numbers in the Orkneys, Hebrides and on the west coast of Scotland, but the shag outnumbers the black cormorant in the west of Ireland and on the Cornish cliffs.

The cormorant is the larger bird of the two; the black plumage has a greenish-purple,

metallic hue, the throat is white, and during the breeding season a white patch appears on the thighs. It has fourteen feathers in the tail.

The shag, or green cormorant, is considerably smaller; the dark plumage has a green, metallic tint, there is no white at any time on the bird, but during the breeding season a dark green crescent develops on the head, the feathers of which are curved forwards. It has only twelve feathers in the tail.

The two species also differ in their nesting habits. Cormorants nest in colonies, mainly upon the top of precipitous cliffs, but they also build in trees and sometimes on the ground beside inland waters.

The shag, on the other hand, is a solitary bird. It selects the most inaccessible ledge upon which to build its nest, either on the face of a cliff or in a cave. This species is entirely maritime in its habits.

The cormorant is a more timid bird than the shag, and when both are sitting together on a rock in the sea the former will take to flight and skim away over the surface of the water when a boat is still two or three hundred yards away. The shag usually remains considerably longer,

and, when it leaves the rock, drops on the water with a tremendous splash, swims a few yards, and then disappears below the surface with scarce a ripple.

I have never yet made up my mind which has the worst smell, a cormorant rookery, a gannetry, or a crowded heronry. If, however, the reader decides to spend a time concealed among cormorants, I can guarantee that the observation of the quaint habits of this bird will amply repay the inconvenience caused by the stench.

The nest of the cormorant consists of a large piled-up structure made of seaweed, marine plants and debris from the shore. Old nests are rebuilt year by year until they become ungainly structures. The eggs, usually three to five in number, are white, with a rough chalky surface. A peculiarity of the cormorant family is the spread-eagle attitude which these birds assume, and they will sit in this position for an hour or two at a time, motionless except for a waggle of the tail or an occasional flapping of the wings. It would appear as if the pose afforded ease to the bird when distended with fish, for the cormorant always sits in this position after a

Cormorant with Wings Extended.

Cormorant Swimming on the Surface.

heavy meal. The upper illustration on the accompanying plate shows this attitude.

The lower photograph on the same plate shows a cormorant swimming on the surface. The bird is by no means the entirely black object it appears in the distance, for the bronze-brown wing coverts have distinct blackish-green margins. It will be seen in the photograph how these markings fit in with the ripple pattern on the water.

Cormorants consume a prodigious quantity of fish. I have watched them feeding in the sea off Cornwall, in the Hebrides and on fresh waters, and though a bird only weighs six to eight pounds, it consumes at least fifteen pounds weight of fish a day; some authorities place the total considerably higher.

An extraordinarily large amount can also be taken at one time. A Scarborough naturalist gave a bird fifty herrings, all of which were swallowed. On one occasion I gave a small captive cormorant all the fish he wanted, and he took twenty-seven herrings of an average length of seven inches.

Reliable records are available of specimens which contained respectively a conger 2 ft. 6 in.

in length, a grilse weighing 3 lb. 2 oz., and six trout weighing 2 lb. 4 oz.

The question naturally arises: How does this bird manage to catch all the fish required to satisfy its enormous appetite with such ease that it is able to spend most of its time perched, as a sentinel, upon some lonely rock or tree?

I would suggest that fish are attracted to the bird by the "flash" from the black, glossy lustre of its plumage. The extent of "flash" from a glossy-plumaged bird has already been illustrated in the introductory chapter. The "flash" from the cormorant is again shown on the opposite page. A single illustration, however, does not by any means give a true idea of the "flash" from a diver. In the photograph the light is upon the neck and shoulders, but, as the active bird twists and turns, at the next moment the neck and shoulders may be invisible and a "flash" appear from the head and tail.

In this manner, as the cormorant races through the water, bright streaks of light travel along the head, neck and body, and flash at different points. These flashes resemble the turning movements of shoaling fish, and the

Cormorant searching for Fish in Dark Water.

pollack, cod or bass are attracted to their destruction.

The cormorant also hunts his prey while he swims on the surface. When the bird fishes in this manner he dips his head below the water and swims forward with it submerged; he then raises the head, looks round, and dips it down again. These manœuvres are continued until he sees a fish, when he dives and gives chase.

The three top photographs on the plate facing page 32—taken from a cinematograph film—illustrate the movements of the head.

The bottom illustration on the same plate shows the "flash" from the head of the cormorant, as seen from below the water, while he was swimming as described.

I would suggest that when a pollack sees such a "flash" from the head of a cormorant it suddenly turns and, in turn, flashes. The cormorant detects the "flash" of the fish, instantly draws up his legs under his breast, expands his large webbed feet, gives one powerful stroke downwards, tips up, and disappears with a swirl below the surface. A chase ensues, but the pollack signals his course as he turns in his endeavours to escape, and it is not long before

the rapid-swimming cormorant has seized his prey across the middle. The bird then comes up to the surface, and the fish is turned and swallowed head first.

I do not suggest that the cormorant puts his head under *in order to* "*flash*"; he does it so as to see below the surface. Incidentally the "flash" attracts the prey to the bird.

In 1913 I watched a cormorant in Port Erin harbour behave in the manner I have described. Pollack were in the bay. I had fished for an hour, but never touched a fin; the bird came up five times with a nice fish. The fifth was a pollack of at least a pound in weight; this the bird found difficult to swallow, and for a time swam about with the tail of the fish sticking out of his mouth.

The cormorant then indulged in certain antics which it was hard to follow from the distance, but I have seen my own captive cormorant in the same difficulty, and have watched these movements at close quarters. First, the bird commenced to tread water rapidly, with the result that the body was raised well above the surface. The neck was then straightened and the upper portion arched, so

Cormorant Dipping in Search of Fish.
(*From Cinematograph Film.*)

Appearance of the same Bird as seen from below the Water

that the fish was held and literally pushed down the gullet; at the same time the gullet below appeared to be inflated. Occasionally this pushing action was alternated with a violent shaking of the head.

The actual distance that a cormorant can travel under the water without coming to the surface is given by various authorities as from seventy to one hundred and twenty yards. I personally consider the shorter distance nearer the mark.

As the bird does not stay under the water more than a few seconds, it will be seen that it travels at no mean rate even if it were to swim straight forward. But the cormorant very seldom swims straight ahead; as a rule it behaves like the otter under the water, and twists and turns this way and that in its search for fish.

The two illustrations on the plate facing page 34 show the cormorant fishing under the water. When the upper photograph was taken the bird swam round and regularly quartered the ground in its search along the bottom.

The lower illustration shows how it chased a fish down and then seized it across the back. At

the same time the bird expanded and elevated the tail feathers and dropped the feet so as to check its onward rush.

The tail feathers are remarkably strong and most effective for this purpose. These stiff feathers are also used as a prop when the bird sits upon a rock in the erect position.

When a cormorant has caught a fish too large for it to swallow it is extremely persistent in its endeavours to perform the impossible. I have seen the bird twist a plaice round and round for ten to fifteen minutes before it dropped it in disgust. When I picked it up the flat fish was dead, with holes all round its body made by the powerful hook in the upper mandible of the bird.

There is no doubt the cormorant destroys a large number of fish in this way over and above those it actually devours.

While I was in the Outer Hebrides I came across an instance of a cormorant killing a codling half its own weight. This, of course, was quite useless to the bird.

Though the cormorant undoubtedly takes a large number of edible fish in the sea, it is when the bird visits inland waters and rivers that it

Cormorant Diving.

Cormorant Catching a Fish.

may safely be said that he is responsible for the destruction of fish to the value of several pounds a day.

If unmolested, a few cormorants will ruin any fresh-water fishing. A colony at one time built in the trees at Lough Tawnyard, County Mayo, where they played havoc among the trout; and for a time cormorants ruined the fishing near Towyn, in Wales. These are merely two examples of what has frequently happened, because those interested in the fishing do not fully realise the ways of the cormorants. If a gang of poachers are found to be netting a water, the owners immediately take measures to prevent the poaching; but a pair of cormorants will do far more harm by their regular toll of the trout than an occasional visit of the poacher. Yet the cormorants are allowed to remain, because it entails so much trouble to shoot them!

Owners of salmon rivers have not infrequently taken combined action to improve the run of fish, but they have seldom gone to the trouble of preventing a flock of cormorants fishing in the estuary during the time that smolts are running down. Many thousands of prospec-

tive salmon are lost in this manner, and much of the keepers' work on the upper waters wasted.

I know it will be said that the smolts are taken by congers and other predatory fish in the sea. That is so; it emphasises the need to remove those enemies of the young salmon which can be readily dealt with.

Before I can expect the reader to accept the theory that "flashes" from the diver attract fish to it, it will be necessary to show that divers in general "flash" in a similar manner. This is not difficult, for not only do all divers "flash," but the plumage of those divers that fish in dark, deep waters are exceptionally arranged to simulate the flashings of fish.

One of the best examples of this is to be found in the great northern diver. This bird remains under the water for several minutes at a time. It dives deep, and can swim 150 to 200 yards before it comes up, though on occasions it can greatly exceed this distance.

This handsome bird is not uncommon in the northern parts of our isles, but it is essentially an Arctic bird, and fishes in sombre surroundings where there is insufficient light under the

water to cause a "flash" from the sheen on its plumage.

The back of the great northern diver is covered with numerous white spots. These white spots do undoubtedly sparkle, even at a considerable depth, like a swinging shoal of fry. I have shown the power of white as a reflector under the water.

Those who are unfamiliar with the plumage of the great northern diver I would refer to the illustration opposite page 17 in Vol. VI. of Morris's "History of British Birds." Morris's description is:

"Breast white, back dusty, spotted all over with oblong, oval and round spots of white; each feather has two spots, one on either side of the shaft near the tip, forming rows."

The plumage of the great northern diver appears to me, *par excellence*, an example of aggressive concealment. The white breast conceals the bird's approach while it is in the area of total reflection, and under the water the back simulates a shoal of small shining fish.

The white-billed northern diver is a bird that only accidentally leaves the Arctic circles. The

white marks on its back are even more prominent.

With the razorbill we find well-defined narrow white bands on the beak.

The small, black-footed penguin affords a very good example of attractive "flash" from white plumage.

I illustrate on the plate opposite the penguin as shown standing on a rock. The neck and side of the head are white, and this white plumage is extended as a line down to the tail; the back is dark, and the breast is white.

The two lower illustrations show the same bird swimming under water. These under-water illustrations are from cinematograph films. It will be seen that the dark back of the bird is invisible in the dark surroundings, for there is no sheen on the plumage of a penguin, and top light is not reflected. The white breast reflects the darkness below, while the white plumage on the side of the head and body catches the light from above and gives the "flash."

The penguin is a heavy bird. Its wings are small, and as it flies through the water with an undulating movement the "flash" very much simulates the flash from a heavy silver spoon-

Penguin on Land and Fishing in Dark Water.
(From Cinematograph Film.)

bait. Of the under-water photographs on the plate, the lower was taken one-fifth of a second after the first, and it will be seen how the "flash" altered in that time.

When the entire film from which these two illustrations were cut is shown, the penguin is not detected, because the eye of the observer is arrested by the *flash*, *flash*, *flash* of the white plumage.

The next question which arises is: Are the "flashes" from a diver arranged by Nature so that the bird attracts its prey, or are these flashes a scheme for recognition among gregarious divers?

The cormorant has a glossy plumage so as to permit the bird to slip rapidly through the water, and the "flash" is therefore merely accidental, but for all that none the less effective.

Whatever was the original purpose in the arrangements of white in the plumage of such birds as the great northern diver and the penguin, they certainly flash under the water like shoaling fish, and if these marks were intended for recognition, personally, I think they would have been better arranged.

Before I pass on from the consideration of

the penguin I should like to draw attention to the movements of this bird under water. The flight is by means of regular and rhythmic strokes of the featherless wings, and both feet are trailed out straight behind the bird. When the penguin desires to turn it does not do so by unequal strokes of the wings, but depresses one foot or the other, and when it wishes to come to the surface it elevates its stiff tail in much the same manner as the tail of an aeroplane is operated. To catch a fish the bird generally comes up from beneath it and seizes it across the middle, but the capture is invariably turned and swallowed head first.

The photographs opposite of a penguin catching a fish were taken with a special lighting so as to show up the movements of the bird under the water. In the third picture it will be seen how the penguin stopped its progress through the water as soon as it had caught its fish by depressing the webbed feet. Unlike the cormorant, who comes up to the surface to swallow each capture, a penguin will swallow several fair-sized specimens under the water.

Penguins, like cormorants, devour large quantities of fish, but all divers appear to be

Black-footed Penguin catching, turning and swallowing a Fish.

(*From Cinematograph Film.*)

possessed of inordinate appetites. Even the innocent-looking little grebe, or dabchick, can, and does, destroy quantities of fry. I have kept a pair of little grebes and fed them in a large tank. Each bird was given twenty minnows a day, but I found this was quite insufficient and the grebes rapidly lost flesh.

A year or two before the war Mr. Seth Smith wrote a very interesting account in the zoological notes of *The Field* about the feeding of this bird. Each grebe was given forty to fifty small fish from one to two inches in length daily.

Since keeping dabchicks I have examined the contents of a few of these birds in order to arrive at a knowledge of their feeding habits in a wild state. The little grebe has a gizzard as large as that of the black-headed gull, and I have invariably found it full of food.

Whenever small fish are present, the grebe, like all other divers, prefers this form of food. A specimen was shot on the Deben, and contained eight recognisable blennies, two to two and a half inches in length, and 258 otoliths of various sizes. It had, therefore, certainly devoured 137 small fish within the previous forty-eight hours. Another specimen contained

remains of six or seven blennies and fifty otoliths. A month later I examined two other little grebes shot on the same water; one contained twenty shrimps (*Pandalus annulicornis*) and two to three hundred mysids, the second bird contained fifteen shrimps and about one hundred mysids. Though dabchicks devour enormous quantities of small fish whenever these are available, they also eat large quantities of insects, including the larvæ of the dragon fly and of the great water beetle (*Dysticus*), both of which insects are detrimental to fish culture. This fact is always put forward as an argument in favour of the dabchick, but it must be remembered that if a dabchick gets on to ponds or water where there are trout fry, the bird is going to have the fish first.

I find on referring to my records that I have only examined the contents of some fifty divers, because these examinations merely confirmed what is already known—viz. that divers devour enormous quantities of fish.

Though the feeding habits of divers probably have very little influence when these birds feed in the open sea, the destruction of enormous numbers of spawning fish in shallow waters round

the coast must of necessity damage our fisheries. In the estuaries of rivers divers are a distinct menace, and in confined waters, if unmolested, they will rapidly destroy the best fishing.

In 1919 I spent a few weeks on the Cornish coast after six years' absence, and was very much struck by the enormous increase in the numbers of shags and cormorants. Off Land's End and Sennen every rock was crowded with these birds. On inquiry I found that the shilling reward offered for each shag or cormorant had been stopped in order to effect economy. While millions were being wasted, a few hundreds a year were saved, with the result that at the present time there is an ever-increasing destruction of edible fish, the value of which can be estimated at many thousands of pounds. It is to be hoped that the Fishery Boards in these areas will now reconsider their short-sighted policy.

CHAPTER III

THE OTTER AND SEAL

DURING several holidays spent in the Hebrides, in Suffolk, and in Lancashire, I have made a study of the otter and his ways, and endeavoured to learn as much about him as possible, and as I have tamed and kept three of these animals upon my observation ponds I feel that I am not presuming in writing at some length about the otter and its habits.

In northern streams, when the water runs low and clear, many a good catch of sea trout can be made round about the hours of midnight. If it were only the question of a fish or two taken between 10 P.M. and 1 A.M. I, personally, should prefer to keep my bed and kill my fish in a more orthodox manner, but night fishing has charms beyond the mere catching of fish.

It was during an August holiday that I had whiled away a hot summer's day on the banks of the Hodder. I had marked down where the

best fish lay, made a note of the snags to be avoided in the dark, and had gauged the length of line required to fish the various parts of the pool selected—for seldom does the night angler move from one pool to another.

During the afternoon I returned to the hotel for a substantial meal, then put on my waders, and leisurely strolled back to wait by the side of the pool where I had made my observations.

My arrival sent to ground the rabbits in the wood opposite, but dusk inspired confidence, and very soon they again began to frolic and play, and an occasional stone loosened by their capers rolled downhill to fall with a splash into the water below.

At the bend of the river a heron alighted, and for twenty minutes remained motionless in the water; but no fish came his way, so he commenced to stalk majestically upstream with outstretched neck. When nearly opposite the old tree trunk upon which I was seated he became aware of my presence, flapped out of the water, and then gracefully sailed overhead, his great wings and trailing legs silhouetted against the darkening sky. But he only flew to the pool above, where he continued to fish. This bird

evidently knew the night angler, and it was as though he said : " No doubt you are quite harmless, only poaching, like myself; nevertheless I prefer to keep you at a respectable distance."

For the last half-hour the fish had been on the move, and at length it was sufficiently dark to commence operations without much risk of disturbing the sea trout. I carefully waded in, and continued to cast a short line in front of me and on either side until I was up to my waist, then I knew my flies were dropping into deep water under the shelving rocks on the opposite bank.

It was no longer possible to see the rising fish, but the *plosh*, *plosh* as they fell back after a rise suggested that they meant business.

The start, however, was not propitious; short rise followed upon short rise, and fish were missed. Suddenly there was a swirl, and I knew I was into a good trout, but before I had got on level terms he came straight towards me, dashed between my legs, snapped the gut, and was off.

There was nothing for it but to go ashore and put on another cast. The expert night angler does this in the dark, but I had only tried the

game once before, and so had brought an electric torch. A second attempt was more successful, for without the suspicion of a rise there was a touch. I struck, and for a moment all was still; then the reel screeched as a fish dashed down the stream. The gut was strong, so I gave him the butt, and in less than five minutes he was in the net. I then turned on the torch, and the light was flashed back from the silvery sides of a fresh-run sea trout—two pounds if an ounce. Six times I fished the pool from end to end, and added two more trout to the basket.

It was at the close of such a night as this, that I was thinking of going home when I heard a distant whistle downstream. The whistle became louder and louder and then ceased. I crept out of the water and lay on the bank. Then from the pool below there came a shrill metallic note; small wonder that the sound carried miles up the valley in the still night air!

It was an otter. The beast continued to whistle, and at length there came the answering note from its mate; then all was still except for the babble of running water and the occasional hoot of an owl. Presently I heard otters at play; they had had their fill of fish, and one had

called to the other to come and have a game. Their gambols over, they probably floated downstream to a distant hover, and I returned to the hotel—to dream of landing a silvery otter on a ten-foot split-cane rod.

This was my introduction to *Lutra vulgaris*, and since I have found him to be one of the most fascinating of animals.

The habits of the otter have always been a source of interest to both the naturalist and the sportsman, and in consequence, notwithstanding his nocturnal habits, we have considerable knowledge of his ways.

A litter of otter generally consists of two to four cubs; sometimes there are five, and a litter of six was once found on the banks of the Moselle on July 26th, 1911.* The usual number, however, is three.

The young are generally found in the hollow of a tree down by the water's edge or in a hole among the roots, but a cleft in the rocks, a hollow in a bank, a sheltered nook on a wild bog, or a well-concealed spot in an osier bed may be the place selected by the mother in which to rear her offspring. The nest itself is prepared

*Report of Lorraine Fishery Association.

The Young Otter Strays from the Hover.

with considerable care, and is usually lined with moss, fur or wool.

The otter is a most attentive parent, and, except to feed, seldom leaves her young for the first two months. Occasionally, when the nest or "hover" is by the water's edge, the cubs are flooded out; then the mother removes her family by the scruff of the neck to a place of safety, and has been known to carry them long distances in this manner.

Otter cubs, even when quite young, are very restless, and require to be constantly watched to prevent them from straying. Sometimes one manages to escape while the parent is absent on a fishing excursion. He leaves with all the confidence of youth, but presently comes to water which he dare not face. The wanderer is not, however, allowed to go far, for the mother on her return quickly follows him up and drives him back to the hover.

The otter is one of the terrestrial carnivora, and is a near relative of the badger, pine marten, stoat, weasel and ferret. It can run, jump, climb and fight with the best of them, and originally led a purely terrestrial life like its cousins.

But the time came when, in order to procure food more readily, it had to take to the water and adopt the methods of a fisherman. The hands and feet are now webbed and the tail is a rudder, and the animal is as much at home in water as on land.

The otter, however, has not been fisherman long enough for the cubs to take instinctively to the acquired habits of the parent, and at first they dread the water and have no idea how to fish. When the young are about three months old the parents commence to instruct them in the ways of their future life, and they are taken down to the river bank.

Here the mother tries to persuade them to follow her into the water, but persuasion seldom succeeds, and she has either to carry or push them into the stream. At times she enters the water with the youngsters on her back, and then sinks down so that they are left to swim. The mother, however, is not far off, and at the first sign of distress comes up below them and again lifts them on to her back.

Instruction in fishing commences as soon as the cubs are quite at home in the water. For some time past they have followed their parents

on land, keeping close to their heels, and now they follow them into the water in the same manner, so that undoubtedly they learn something of fishing by example, and their animal instincts are aroused when the old otters come ashore and deposit a flapping fish at their feet. But, in addition to example, they are given definite instruction.

Fish are not only cornered by the parents for the young to catch, but an otter has been seen actually to post her cubs in position and then drive the fish to them.

My informant who witnessed the above procedure was Old Moon, the water bailiff to the Ribble Fishing Association.

Moon has lived his life in the wild country on the borders of Yorkshire and Lancashire, and he is, what one so frequently meets in that part of the world, a born naturalist, who has learnt his natural history entirely from observation.

The upper reaches of the Ribble and Hodder were at one time famous for sea trout and poachers, and also for the number of otters that frequented these waters. For many years most of Moon's nights were spent on Ribble bank,

and in consequence he has had splendid opportunities for observing the habits of these shy creatures.

The water bailiff described to me how, one night as he lay on the bank, he observed an otter and three cubs come to a shallow run of water below a bridge near Clitheroe. The mother kept the cubs in a line across the tail of the pool, while she went to the head and deliberately crossed the river from side to side so as to work the fish down to her youngsters. Their antics showed that the fish were driven down all right, but only one cub managed to catch a trout.

That instruction is necessary before an otter will swim or fish is demonstrated by the following incidents:

Mr. Rose, the Master of the Essex Otter Hounds, took a tame otter, which had been obtained as a cub, down to fish in a well-stocked pond, but nothing would induce it to do anything except walk round and round in the shallow water.

The second case was that of an otter which I had on my ponds, and as this animal's behaviour well illustrates how some of the habits

are due to inherited instinct, whereas others still depend on parental instruction, I will give a somewhat detailed history of this particular otter.

In July, 1909, a lad with his terrier was walking on the banks of the Yare, near Marlesford, in Norfolk, when the dog went into a hollow willow tree and emerged with a dead otter cub in his mouth. Though the lad felt all round the hole, he could not find any more. Next day, however, he caught a cub about three months old near the tree. This grew up to be the animal whose peculiarities I am about to describe. Soon after being captured the young otter came into the possession of a lodge-keeper, by whom she was kept for two years in a large rabbit hutch. The hutch, which was four feet long and two feet wide, was made of thin deal boards, with ordinary wire netting in front. Though she could have escaped from the hutch in five minutes had she wished to do so, she only left it of her own accord on one occasion, and then returned home the next day.

While confined in this manner the animal was fed most erratically—scraps of meat off the table, sometimes a cod's head, brought home on

market day, and on very rare occasions a roach. If there was nothing else, she was given parsnips or other vegetable food; vegetarian diet does not nourish an otter, but even in the wild state a starved animal will take greenstuff to stave off the pangs of hunger.

When two years old this otter came into my possession, and was conveyed from Marlesford to Ipswich without leaving the hutch, in order that she should be disturbed as little as possible. On her arrival, however, she was savage and frightened, and for two days took no food. After a time she became accustomed to my man, Bullock, and would come to the front of the hutch and feed from his hand. A fortnight after her arrival she was transferred to a tin-lined kennel.

This kennel was placed against the enclosure round the pond, so that when the grating in front was open the otter was free to roam in the enclosure. For a week it was impossible to induce her to leave the kennel; then it occurred to my man to pour water on her out of a watering can. The animal so much objected to this procedure that at once she shot out of the kennel and retired to a hole among the rocks on the

bank. Here she would lie all day, and only creep out at dusk.

In the pond were brown trout—Loch Leven and rainbow—from a quarter to half a pound in weight. For three days the otter was given no food, with the idea of seeing whether she would fish for herself, but she made no attempt to enter the water. The pond was then lowered so that there was a small pool with only a foot of water over the fish. Still she abstained, and in the end I had to feed her to prevent her from starving.

At first, when Bullock or I entered the enclosure, she was extremely shy, but, if cornered, would spit and snarl at us. If dislodged from the corner into which she had retired, she avoided by every means going into the water, and made for some other coign of vantage on land.

After a fortnight the timid animal became accustomed to her surroundings, and commenced to take fish from the hand, but still nothing would induce her to go into the water.

I then arranged a gradually sloping bank of shingle from the edge of the pond into two feet of water. Dead fish were first placed at the

water's edge, then under the surface at increasing depths until, finally, they rested on the bottom, two feet below the surface. Still the otter made no attempt to swim out to them, but walked along the bottom until she reached the fish.

Though she refused to swim, her aversion to water was now gone, and she spent a considerable amount of time paddling about or actually walking on the bottom under the water.

Now, when alarmed, she did not hide on land, but went into the shallow water under a rock, where she would crouch down with only her nostrils above the surface. A month passed, and yet the otter showed no signs of swimming. I then pushed her into three feet of water, and she splashed and scrambled across to the other side of the pond. A day or two after this a friend and I surprised her in the evening; alarmed at the sudden appearance of a stranger, she plunged into the water with a tremendous splash and swam away under the surface, leaving a chain of bubbles in her wake. After this she invariably dived for her food, and soon learnt to enter the water as noiselessly as a wild otter.

A glance at the photographs opposite pages

Disturbed.

60 and 62 shows the part the tail plays in enabling the otter to enter the water without a ripple. In these illustrations it will be seen how the powerful tail grips the rock, so that the body slips into the water with a steady though rapid movement.

Though otters require parental instruction to persuade them to take to the water and fish, many of their habits are inherited, e.g. the otter just described had the night instinct very strongly developed. If left alone she would lie up all day, and only come out at dusk; her shyness also, to a great extent, disappeared with darkness.

Again, the playful spirit was most marked. Although this animal had been shut up in a rabbit hutch for two years, after a fortnight's freedom on the pond she was at times as skittish as a kitten. Before she took to the water, sprats were provided on land, and when her appetite was satisfied she would throw the glittering fish up in the air and catch them again to toss them from paw to paw. Later, even when the moment before she had been swearing and cowering in a corner, as soon as the broom with which the enclosure was swept was twirled in the water, she could not resist the temptation to play, and would circle round and round, now

on the top, now pushing it away with her feet, yet all the time ready to bolt if a stranger came too near.

It is usual to speak of the otter as a poor hunted vagrant, against whom the hand of every man is turned, but it appears to me that the life of the otter is one of the best. For weeks together the animal can fish at night—first for food, and then for sport, after which it can romp and frolic, and then sleep peacefully during the heat of the day. Certainly, keepers and water bailiffs wage war on its kind, but otters are intelligent, and comparatively few are trapped. Occasionally it is hunted, but otter-hound packs are not numerous, and many thousands of otters in Britain have never heard the "heu gaze."

Soon after the young have learnt to fish, the dog leaves the family, but the mother and the cubs, except for accidents, keep together during the summer months.

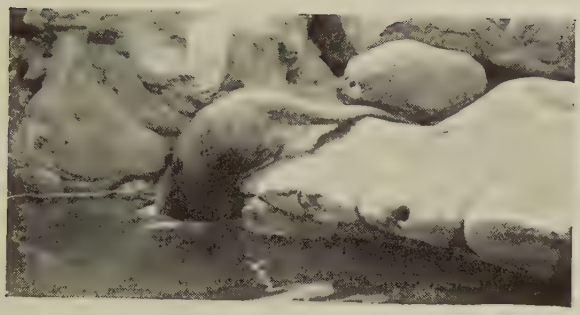
Let us follow them during their wanderings. The day had been passed in the hollow of an old gnarled willow by the side of an overgrown ditch. Towards evening the cubs became restless, but the hover was quite close to a farm-

stead, and the shepherd was still at work, so the last rays of the sun had faded from the sky before the mother allowed her offspring to show themselves. As soon as the family—the mother, a young dog, and two females—left the willow tree, they started straight off at a good swinging trot across the meadows down to the river. The parent led the way; there was nothing haphazard about her movements, for she had made up her mind exactly where she intended her family to fish. After travelling nearly a mile, she again struck the river. Below was a beautiful pool, one hundred yards in length. At the head of this stretch of water a rocky bluff had turned the river's course, and with its waters confined in a narrow channel the restless river swept along to fall with a dull roar into the pool. The bluff extended as a rocky wall along one side; here the water ran deep, and from this wall the bed of the river gradually sloped up to a shingly bank opposite.

Full well the old otter knew sea trout and salmon had recently run up, and that the fish would remain in the deep water until a flood enabled them to continue to work upstream. Together the family waded into the shallow water

at the tail of the pool, and then for some distance paddled on the surface; simultaneously, as if at a given signal, mother and cubs dived. At first they continued to use both hind and fore limbs until they had gained sufficient way, then the fore legs were laid back on the chest, and each beast continued to propel itself with powerful strokes of the hind legs alone. In this manner the otters advanced in line along the bottom, inclining their course to right or left by the occasional stroke of one or other of the fore paws. Suddenly a sea trout shot away in front of them. Experience had taught these fishers that their prey would take shelter under a boulder; in consequence, they now entirely altered their tactics, and, with hind legs extended on either side of the tail, they paddled with the fore paws alone, and in this way diligently searched under each stone.

It was the dog that flushed the fish, which, like a flash, shot downstream. At once, with a swish of the hindquarters, he turned as if on a pivot and dashed after the trout. Now he struck out with all four limbs, and twisted and turned more like an eel than an animal as he swam over boulder and under shelving rock.



Otter Searching for Fish.

The other otters joined in the chase, but the prey continued for a time to escape capture, and one by one they had all to come to the surface to vent. Down again, and once more the fish was flushed. On this occasion the male cub got his teeth into the shoulders of the sea trout as it doubled back to escape from the old otter.

Still swimming under water, the cub went ashore with his prize, and as soon as he reached the bank scrambled up the rocks. One of the other cubs followed her successful brother ashore with the idea of sharing his capture, but the dog went for her, bit her on the head, and drove her into the water. The mother and two cubs now continued to hunt, and before long all four otters were chewing their fish, the young dog on the rock at the tail of the pool, his sisters on a bank of shingle, and the mother on a projecting boulder in the middle of the stream.

The old otter had done most of the work and was hungry, so she started at the head of a two-pound sea trout and ate it down to the tail, only stopping occasionally for a drink. The meal finished, she again slipped into the water to fish; a splash of blood and a few scales alone

marked the spot where the trout had been devoured.

The pool still held several fish, and these inveterate hunters were loath to leave them, but at last the mother went ashore, shook herself, and commenced to roll on the shingle and rub the back of her neck on the small stones, for now that her hunger was satisfied she had time to think of the irritation caused by the tics attached to her skin where she could not reach them with her teeth. Two of the cubs were at play; one moment they appeared to spar, next instant, locked in a friendly embrace, they rolled over and over like a ball into the water. The third toyed with a fish like a cat plays with a mouse, and time after time knocked it into the stream, then dived in and fetched it out again. But the frolicking of the cubs in the water was too much for the other two, and presently they were all at play in the pool. Suddenly the old otter broke away and swam ashore, shook herself, gave a half whine, half whistle, and started upstream, and before she was at the head of the pool the cubs were at her heels. The mother led the way across two meadows, past a pool—where the young otters

The Mother Otter Finishes a Two-pound Sea Trout.

wished to tarry—then along the river bank, until they arrived where two streams joined to form the river up which they had travelled. Below the junction was a deep pool with a spit of yellow sand on the opposite bank. The otters entered the water and again fished, then they landed, and here they left on the damp sand the tell-tale *seal* or footprint. This was the only sign on the following day of the fishing party, for the rats and gulls soon cleared away the remnants of any fish that had been left.

A glow in the sky towards the east now indicated the approach of dawn, and the behaviour of the otters at once changed. Alternatively swimming, floating or wading, they dropped downstream without another thought of play, past the rocky pool where they had started to fish, past the opening of the ditch, up which they had "hovered" the previous day, to a pool a mile farther down the river. Here the mother landed on the bank, passed through the rushes, and led her cubs to a dry drain fifty yards from the river. By this time the hills were rimmed by the glow of the rising sun.

It was daylight when the otters reached their

resting place; perhaps the mother was trusting to the low-lying mist to hide her offspring from prying eyes. In the drain each animal licked itself all over, then, huddled together, they fell asleep.

An hour before dusk there was a movement in the rushes, and the mother crept out on to the shingle; carefully she turned from side to side and sniffed the air, then slipped into the river and came up in the middle of the pool, where she raised herself in the water and looked round. Satisfied that all was clear, she returned to the drain, and in a few minutes reappeared with the cubs. It was evident that something was afoot, for silently they fished in the pool, and after a trout apiece they started to travel at a rapid rate upstream. At dawn the family had followed the course of the river as they dropped down to their hover, but now the mother left the water and made across the fields, past the hover in the willow tree, and then on to the rocky pool where they had fished the previous night. By this route she cut off a great sweep of the river. The old otter had no intention of stopping to fish in the pool, and she continued her course over the rocks, but the dog cub

silently slipped into the water. The rest of the party had passed the bluff at the head of the pool and were crossing the meadow above before the mother noticed his absence; at once she stopped and whistled, but there was no response, so she went on with the two smaller cubs. Every now and then the mother repeated the whistle, and at last there was an answering note. Though the mother knew she had many miles to cover before dawn, her maternal instinct caused her to slacken her pace, and presently the errant dog joined the family. Next they reached the pool where the two streams met, and here they fished, but not for long, for the mother had made her plans before she left the hover, and very soon turned up the stream to the left. Hurrying along, the family passed under an old Roman bridge over which Cromwell had led his Ironsides, then through the arches of a more modern structure better adapted to take the traffic of the present day; past a big house high up on the river bank where some studious individuals were burning the midnight oil, then again through wood and meadow until they came to the outskirts of a town. As the otters followed the river, the towering walls of a cotton

mill loomed above them. Suddenly the mother stopped and crouched in the shallow water at the foot of the wall, for she had heard a throbbing sound in the distance—the sound became louder and louder until a flood of light swept round the bend of the road which ran by the riverside, and a motor-car passed over the bridge which spanned the water a hundred yards farther up. The motor passed, the otters hurried on and never stopped until they were clear of all signs of man. Now the scenery changed, and outcrops of rock caused the river to twist and turn and travel alternately through deep pot-hole and over shallow run.

It was at the largest of these pot-holes that the parent stopped, and the otters commenced to fish. Now it was evident why the otter had brought her cubs miles up the river, for as they searched the pool they found two fish nearly as long, almost as strong, but more active in the water than even an otter; they were salmon, and had run up with the last flood. The hunt was long and furious, but in the end the combined effort of the family was too much for the fish. Two clean-run salmon were hauled ashore and devoured to the accompaniment of much

hissing and snarling; the family then lay up for the day in a cleft among the rocks.

Such are the happy nights and days of the otter. True, a gamekeeper might have been standing on the Roman bridge and put a charge of shot into one of the cubs; if so, it would have been a painless death, and though the mother and the other cubs would have been scared, they would have hunted and killed their salmon all the same.

The seal of the otters might have been noticed as they passed from the hover in the willow tree to fish in the rocky pool, and a trap placed on their track in the hope that on the following night they would travel the same way. This they certainly did, but the old otter had already lost two toes in a gin, and it was very unlikely that she would be caught tripping twice.

What of the dog, the father of the family whose wanderings we have just followed? When he left the care of the cubs to the mother the roving spirit took possession of him, and on the second night he arrived at the very source of the river. After killing a few spawning fish, he left the shallow waters and travelled across country to a large reservoir on the other side of the hills.

This reservoir provided the water supply for a town forty miles away, and had been built about six years. No sooner was the work of holding up a huge volume of water completed than fifty thousand trout fry were turned in. There was practically no natural food in the newly-built reservoir, so that as soon as the stronger of the fry grew slightly larger than their brethren they became cannibals, with the result that when the otter arrived, instead of finding a well-stocked sheet of water, this lake held but a few hundred fish of two to three pounds in weight. These large fish never rose to a fly, and during the day rested in the deep waters in the centre.

In the morning, and occasionally on a warm summer evening, they swam round the shores and fed on the minnows which now were plentiful among the vegetation which had grown up at the shallow end of the reservoir. As the trout swam round the minnows made for the shore, and the large fish splashed and almost threw themselves on the bank as they chased the shoals.

The otter arrived at the reservoir at dawn, and though he fished hard he caught nothing, for the water was sixty feet deep in the centre, and when he chased a trout the fish made for the

depths and disappeared. So the old dog left the water without a meal, and retired to a bed of rushes near the water's edge. Deliberately he bit off several stems and arranged them round in the form of a rude nest, then he turned round and round to make a comfortable hole in which to lie. Next he turned on his back and licked his chest and body all over. At last, satisfied with his toilet, he curled up like a cat and was soon asleep. He had not been asleep for more than an hour or two when he was awakened by the violent splashing of a big trout only a few yards from his hover. It was broad daylight, but the seclusion at the top end of the reservoir appeared to give the animal confidence; he was out of the rushes in a moment and into the water, and no sooner was he in the water than he was out again with a glorious golden trout—he had taken the feeding fish unawares. Next night he again fished unsuccessfully, so left for fresh feeding grounds and followed the overflow from the reservoir. This led him through boggy land, overgrown with coarse grass and cotton plant. There were no fish in the water, so the otter turned his attention to frogs and young plover. He now left the high ground and struck a stream

in the valley below, where he returned to a trout diet. When the sport was good he stayed a day or two, but the roving spirit was still upon him, and he continued to follow the river towards the sea. Three times he met other otters during his journey, but passed them unheeded.

At last his wanderings brought him to a fishing village at the mouth of the river; this he passed through at dead of night and found himself in the sea.

The bay held hundreds of salmon and sea trout ready to travel up with the first flood, and in the salt water the otter took his toll. Then the animal travelled along the coast, where he fed on flat-fish, mullet and bass, and as he swam with a sinuous movement among the rocks his body had more the appearance of a conger than an otter.

Occasionally he made excursions inland to various ponds and streams, and once to a fish hatchery, where he nearly lost his life. In the autumn he returned over the moors to his old haunts; later he fought a battle, won a mate, and for a time again settled down into family life. That summer he met a pack of the otter hounds; he was a big, proud beast, and when pressed he

simply turned round, faced the pack, and died fighting.

During a hard winter the otter's lot, like that of many another wild animal, is not an enviable one. In districts such as I have described the rivers do not freeze and the open sea is not far distant, but floods make fishing difficult and food is scarce, and when the snow is on the ground the otter is easily tracked and shot or trapped.

In Fen districts, where the otter has to fish in sluggish streams and shallow lakes, the animal is often in a desperate plight when the water freezes. For a time he may be able to keep a hole open and fish under the ice, but during a hard winter he has to turn to rats, water-fowl and even poultry for a living. An old marshman at Acle once described to me how two otters fished in a dyke under the ice for several days; they kept two holes open and swam from one to the other.

In 1911 the animals on my observation pond were frozen out, so I broke a hole for them and they kept it open themselves by biting away the ice. These otters, however, kept the hole open so as to be able to get into the water for a swim, and possibly with the idea of chasing a fish under the ice; it certainly was not hunger with them,

for during this hard spell food was provided on land.

Occasionally stress of circumstances drives the starving otter to human habitations, and here the poor brute often gets but scant sympathy. Nothing could be more revolting than the treatment meted out to one at Aldeburgh, as recorded in the local press. The animal was found in the back yard of the *Aldeburgh Times* office; he greedily ate some fish brought to him, and then escaped into a hay loft. The populace then turned out and hunted him with sticks and guns, and ultimately he was shot.

I have known of two or three similar cases.

I have written this account of the wanderings of an otter family so as to give the reader who knows nothing of the animal a general idea of its life. This account is mainly founded on the observations of the otter in the wild state and on my ponds, but there are certain characteristics to which I would allude more fully.

Reference has been made to the playfulness of the otter. After the animal has eaten all it requires, not only does it toy with fish on the bank, but it plays with its prey in a similar manner under the water. The three photo-

Otter Playing with Pike under Water.

graphs from cinematograph film show this well. On one occasion an otter on the pond after a good chase caught and landed a 3-lb. pike. She then deliberately pushed the fish into the water, and a second chase ensued; a second time the fish was carried ashore and again pushed into the pond. The pike by now was exhausted, and in a dazed state sulked on the bottom; the otter tried to stir it up, but when this failed she caught the pike by the snout and threw it over her head, as shown in the illustration. The fish was then carried ashore and all but one-third of it devoured. The otter evidently was hungry, but she wished to get the maximum of amusement out of the pike before she started her meal.

A gliding movement particularly appeals to the otter. Spreadeagled, the animal may be content to float on the surface of a swift-running stream; at other times it selects a spot where the water, penned into a narrow channel, sweeps down to the pool below. Here time after time it will dive into the entrance of the channel and allow itself to be carried down head first into the seething water below, and then with a graceful bend of the body swing up to the surface.

The perfection of gliding is reached when the

otter makes a slide. Personally, I have never seen an otter slide, but W. T. Long gives a very fine description of one in his "Beasts of the Field." This slide was twenty feet high and had been made with much care on one side of a promontory that jutted into the river. Here a pair of otters spent "the better part of a sunny afternoon sliding down a clay bank with endless delight."

Old Moon described to me how on one occasion he tracked an otter for four miles in the snow. At last he came to a smooth, frozen slide on a long bank that sloped right down to the water's edge. On one side the snow was trodden down by the animals as they climbed to the top. It would appear to be a cold form of amusement, flying head first down an icy slide into freezing water, but apparently an otter does not mind the cold, for, as I have stated, those on my pond used to swim about under the ice, though their food was given to them on land.

In the more populated parts of the British Isles the otter is almost entirely nocturnal in its habits, but in less-frequented areas it is often seen abroad long after sunrise. I have watched an otter kill a grilse on a bright summer morn-

ing in the Hebrides, and the instance related on page 64 of how the mother went into the river to have a look round before allowing her cubs to leave the hover, occurred at least an hour before sunset.

In many parts of the world the otter fishes throughout the day, and in 1917 I watched one at work during the afternoon in the River Auja on the Jaffa—Jerusalem front.

The otters on my observation pond were with me for nearly a year. The first arrival was the tame female, whose early life had been spent in a rabbit-hutch, but soon after she was joined by a wild dog and bitch from Ireland.

The wild bitch never settled down, and so, after a month, was released on a Yorkshire estate.

At one time I had hopes that the dog and the tame otter would breed, but in this I was disappointed. I cannot, however, find any authentic record of otters breeding in captivity, though the experiment has been tried on several occasions.

At first the dog was an ugly customer to deal with, and bit both myself and my man on more than one occasion. After a month or two he

tolerated our entrance into the enclosure, and would take food from the hand, but was always surly in demeanour. The manner in which an understanding first came about between us was as follows:

The old dog was lying near the iron bars of the enclosure when I detected numerous large white tics on the back of his neck, so I scratched the skin with a stick through the bars. This he thoroughly appreciated, and when I entered the enclosure he allowed me to continue the scratching. The next day I gradually shortened my hold on the stick until, finally, I was allowed to scratch with my fingers. For several days I continued at intervals to scratch in this manner, and occasionally I picked off a tic until, at length, they were all removed. After this he would usually allow his neck to be rubbed, but immediately resented an attempt to touch any other part of his body.

Otters taken as cubs are very easily tamed, and make delightful pets, but when two years old the "call of the wild" will be too strong for the animal, and, if free, it will go.

I have already described how the mother and her cubs work together when on a fishing excur-

"Who goes there?"

sion; I will take this opportunity of giving two instances of combined action by otters as related to me by a friend who spent many years in India. On one occasion he was lying on a backwater of the Ganges in order to shoot crocodiles; this backwater was about two hundred feet wide and some two miles in length. Presently he heard the whistling of several otters, and then saw six or seven swimming down abreast right across the water. They continued to whistle to each other for a time, and then, as if at some given signal, all dived below the surface, to reappear again practically simultaneously farther on. This method of fishing was continued the whole length of the backwater, and in this manner the fish were driven to the end. Every now and then one of their number caught a rahu—a carp of 6 lb. to 8 lb. in weight. The otter that had made the capture fell out of the line and took his fish ashore, while the others continued to advance. On the bank the animal devoured a portion of the fish and then rapidly rejoined his comrades.

The remains of any carp left in this manner were not wasted, for up in the air the Brahmini kite, commonly known as the fish-hawk, fol-

lowed up the otters and greedily devoured their leavings.

On another occasion my friend was duck-shooting on the River Sarju in the province of Oude. He was floating down the river in a boat and had his retriever with him. Outside a bed of reeds an otter swam across in front of the boat, and the dog immediately jumped over-board. The otter did not dive, as might have been expected, but raised itself in the water and whistled loudly. When the dog was within a yard of the beast it dived, reappeared behind the retriever, and again raised itself and continued to whistle; each time the animal whistled it appeared to look round as if it expected assist-ance. At last three or four otters appeared in the water, dived, and attacked the dog from below, as the yelps of the retriever indicated. My friend went to the rescue and drove them off, and when he lifted his retriever into the boat he found that its back and side had been bitten in several places.

During the time that I have kept otters in captivity I have had several opportunities to observe the extent to which some of their special senses are developed.

The animal sees well at all times, but at night its sight is remarkable. However dark the night, any of the otters could catch a single fish released into the pond. Their sight was equally good for seeing objects other than fish.

On one occasion I heard the animals fighting at night, so I got up to find out the cause of the disturbance. As it was pitch dark, I picked up a brass candlestick in the hall in order to find my way down to the pond; attached to the candlestick was a pair of old-fashioned snuffers. When I got down to the pond all was again quiet, and I could not see an otter anywhere, but while I was looking round the snuffers became detached from the candlestick and fell into about two feet of water; I was preparing to mark the spot with a view to recovery next morning when I heard a tinkle on the stones; an otter had retrieved the snuffers and was having a game on the opposite bank. It was so dark I could not see my hand in front of me, but the snuffers were seized as soon as they fell into the water.

I experimented later by throwing small shells into the water, and these were invariably recovered, however dark the night.

The hearing of the otter is probably as acute as that of most wild animals, but the sense of smell appears to be more highly developed than usual.

I have frequently heard it suggested that otters smell their prey under the water. With this I do not agree. If the otter depended on smell to find his fish he would not hunt in the methodical manner he usually employs. An otter can, however, detect the variation in the smell of man from a considerable distance. A keen naturalist was most anxious to watch the otters on my pond, and tried to do so on several occasions, but long before he came up to the pond one particular otter would invariably start to snarl and upset the others, and nothing would induce them to behave in a reasonable manner while the stranger was present.

Before considering the influence of the otter upon our fisheries I would draw attention to but one other point, and that is the remarkable agility of the animal under the water. To illustrate these rapid movements eight pictures are shown, cut from three feet of cinematograph film.

Otter turning in the Water after a Fish.

(*From Cinematograph Film.*)

The movements illustrated occupied two or three seconds.

In the first photograph (No. 2 in the illustrations) the otter has spotted the fish above him and has checked his progress by planting his fore feet on the ground. The fish, after a few rapid movements, as shown by the attitudes of the animal, shot down under a stone on the left. The otter now left the ground with a kick-off of his hind legs and a downward swish of the rudder, and finally scrambled on to his fish, as shown in photograph No. 9.

Fish are undoubtedly the favourite food of the otter. Of fresh fish he much prefers the eel. When my captive otters were shown eels they at once became excited and their shyness to a great extent disappeared. They also have a partiality for trout and grayling, particularly the latter, but no coarse fish comes amiss. Otters also feed on frogs, and young birds and even small animals are taken when fishing fails.

Fond as I am of the otter, there is no gainsaying the fact he takes a terrible toll of sizable fish, and in a small stream a protracted visit from a family will ruin the fishing.

There is a general idea that the otter is a

fastidious feeder and that he only eats a choice morsel out of the shoulder of a fish. This is entirely incorrect; the otter is not at all particular what he eats and will devour fish that has been killed some time. When the animal leaves his hover at night he devours every morsel of the first few fish; he starts at the head and eats down to the tail.

When his hunger is appeased he may continue to catch fish for sport, and it is then that he takes a bite or two out of the shoulder, as it were, for luck.

When fish are scarce, and catching them entails considerable trouble, the otter ceases its fishing as soon as its appetite is satisfied, and this is when he amuses himself in some other way. When fish are plentiful and scatter in all directions as he swims through a pool he cannot resist killing.

The best example I know of this is that of the wild otter from Ireland. This animal came over in a box, and on the evening of her arrival I took the box down to the water's edge. As soon as she was released she dived into the water, and came out on the other side with a roach in her mouth. This she at once dropped, and

An Otter with its Catch.

bolted for some rocks, where she hid up for two days.

On her arrival this otter must have been thoroughly scared, as her subsequent behaviour proved, but as she went through the water she flushed this roach and instinctively seized it. The same otter never became tame enough to be interesting, and, as I have stated, was released a month after her arrival.

As an instance of the killing of fish for mere sport I quote an incident related to me by Mr. W. H. Armistead, of the Solway Fishery Company. On one occasion three otters visited his yearling ponds, and during the night killed two thousand fish. One can imagine how these beasts raced through the water and saw red as they seized one fish after another.

Like all other wild animals, the otter at the present time is not nearly so common as he was a century ago. In wilder districts there are still plenty to be found, and so long as the otter is hunted there is no fear of his extermination in more populous areas, for notwithstanding all one heard about "sport" after the war, there will always be sporting landowners who will preserve otters in otter-hunting districts.

The common seal still visits our shores in small numbers, and recently I watched some fishing in the sea off the coast of Cornwall. On many of the outer islands north of Scotland both the common and the grey seal land in considerable numbers. Doubtless during the war they have become still more plentiful.

In 1907 I paid a visit to a whaling station near Tarbert, on the island of Harris, and in the spring of 1914 I again visited this station with my brother. Our intention was to spend some time on one of the more distant islands, so as to observe the feeding habits of gulls, unaffected by the influence of man. On my second visit I found that the old Norwegian manager of the whaling station had passed away, but his place had been taken by his son, who remembered me and so offered to take my brother and myself up to Rona on a whaler.

Rona is an island some six miles in circumference and is situated about forty miles north of the Butt of Lewis. Countless sea birds of many varieties build on the island, and the precipitous cliffs are covered with kittiwakes and divers of all sorts. When the weather permits the common and the grey seal land in large

numbers at one end of the island, and on an adjacent rock.

Before dealing with the habits of seals, it may be of interest if I describe our time on this isolated island.

Some forty years ago Rona was inhabited by a family of about thirty individuals, who carried on primitive cultivation and bred sheep. During the winter these crofters were held up for many months at a time on their little island and warships had frequently to go to their relief. Ultimately the population was taken off and given holdings on the mainland.

Our Norwegian friend, my brother and I duly arrived, jumped on the rocks, while some provisions and an old sail were thrown ashore. In the centre of the island the four walls of a small croft were still standing, and these we roofed with the sail. Adjoining the croft was the cemetery, which consisted of several mounds and a single gravestone over the body of the last chief. Near by were the ruins of a chapel. Under the chapel was a vault, some ten feet square, which was full of the bones of sea birds and sheep. It was evidently the home of some carnivorous animal, and we found marks indicat-

ing where it came in through a hole in the wall. In a day or two the Norwegian left us and promised to send a whaler to take us off in three days. Man proposes but the Atlantic disposes, and we spent ten days on that island before we were able to get away. The weather was rough, but safe on land we were able to enjoy the magnificence of the storm. At times the whole island was swept with spray, but there were intervals of sunshine, during which we dried. When the sea calmed down, seals innumerable landed on the rocks. One evening in the dusk we disturbed a large animal, which bolted down the cliff; it was too dark to recognise what it was, but this was obviously the carnivorous beast that lived in the vault of the chapel and whom we had disturbed. It was not until we were in Stornoway on our way home that we found out what the beast really was.

When the crofters were taken off the island a few sheep were accidentally left; at the time of our visit there were about one hundred and fifty head. Once a year, when the weather permits, the original owners land and take toll of this flock. On one occasion a storm sprang up and the shepherds had to leave suddenly without

their dog. This was the *wild beast of Rona*, and our description of it at Stornoway caused considerable amusement. It had been on the island for two years, and certainly was wild, and up to that time had evaded all attempts to capture or shoot it.

Owing to our prolonged stay on the island our provisions ran short, but there were plenty of fresh gulls' eggs and we *borrowed* a lamb. The only trouble was the water; this was brackish, and the gulls bathed in the hole where it welled up!

To return to the seals. Both common and grey seals landed on a large rock near by. Unfortunately the boat in which we landed was broken up during the storm, and so we had to content ourselves with watching these animals through our glasses.

The seal is an animal capable of withstanding great privation, and its powers of endurance are extraordinary. During the winter it has to maintain itself in the tempestuous ocean for long periods without landing, which must entail constant exertion on the part of this air-breathing animal. At night these beasts barked and howled below us, but during the day they either

fished or basked in the sunshine on the rocks. Here they appeared thoroughly to enjoy the quiet time after the rough and tumble of the recent storm.

The quantity of fish that a seal devours is enormous. Before the war Scandinavian countries offered rewards for their destruction, and very large numbers were killed annually. Like the otter, the seal hunts his fish systematically. Many years ago I once watched a young seal fishing in a large rock pool. Slowly he worked his way through each mass of seaweed. As soon as a fish was flushed he was after it like a flash, caught it, and then came to the surface and devoured his prey. In addition to fish, seal eat crabs and other crustaceans.

The common seal is a small animal, seldom exceeding five feet in length. It becomes extremely tame in captivity. Doubtless many of my readers have seen Captain Woodward's performing sea-lions. The part of the clown in the performance was taken by a common seal. When Captain Woodward went to South Africa with his troupe, the understudy to the clown, an animal about four feet in length, took up his abode at the Zoological Gardens. From London

Searching for Fish.

Swinging up to the Surface.

The Common Seal.

he paid a visit to Ipswich, and for a time lived on one of my ponds. He arrived in a packing case. When the case was opened he ate half a dozen herrings from the hand, then scrambled out and flopped into the water. This seal was with me in 1913. There was a railway strike on at the time which affected the supply of fish, and I soon found out what a very expensive visitor a seal can be. I procured, however, a large number of live roach in the district and watched and photographed the animal fishing. Though very clumsy on the land, the agility of the seal under the water is wonderful. He twisted and turned with the greatest ease in his own length, and frequently caught his fish by coming up beneath it, with the under part of his body uppermost.

A large fish he would bring to the surface and slowly chew while he balanced himself in perpendicular position in the water. Small fish he swallowed below the surface. When he took a herring he partially closed his teeth, and as the fish was sucked down a shower of scales flew off the body of the fish.

On the plate opposite page 88 is a photograph of the animal searching for fish, and the lower

illustration on the same plate shows him swinging up to the surface to breathe.

With the otter, bubbles of air continue to escape from the nostrils while the animal is under water, which makes the *chain*. The seal, however, keeps the nostrils tight closed under water, and as soon as he comes to the surface he widely dilates them, and blows the foul air out of his lungs.

After a good feed this animal would scramble on to a large rock by the side of the water and digest his meal. Here he would lie for an hour or two unless disturbed by our fox terrier. It was the delight of this dog to bark and jump round the resting beast until finally the seal could stand it no longer and plunged into the pond. The seal then swam under water to the other side, but the terrier was there before him and barked furiously as the seal's head appeared. The seal never took it very seriously and was more disgusted than annoyed. The proceeding, however, gave several opportunities to photograph the facial expression of a seal as shown on the plate opposite.

Peace.

Alarm.

Retreat.

The Common Seal.

CHAPTER IV

THE HERON

BEFORE I describe the appearance of a wader as seen from below the water I will refer to one or two points, already dealt with in the first chapter, so far as they affect the appearance of wading birds.

When a wader stands on the shore by the edge of the water the observer below the surface can only see the dwarfed and distorted image of the head, or head and shoulders. This image appears as if up in a gallery above the arc of the observer's "window." The amount of the bird visible in this position depends upon the distance between it and the observer, and whether it is right down by the water's edge or on a higher level. All objects beyond, such as reeds in the water, a tree on the bank, a distant wood, appear in a like manner above the observer. Further, all these objects seem to be on the same plane, and the pattern made by the plumage

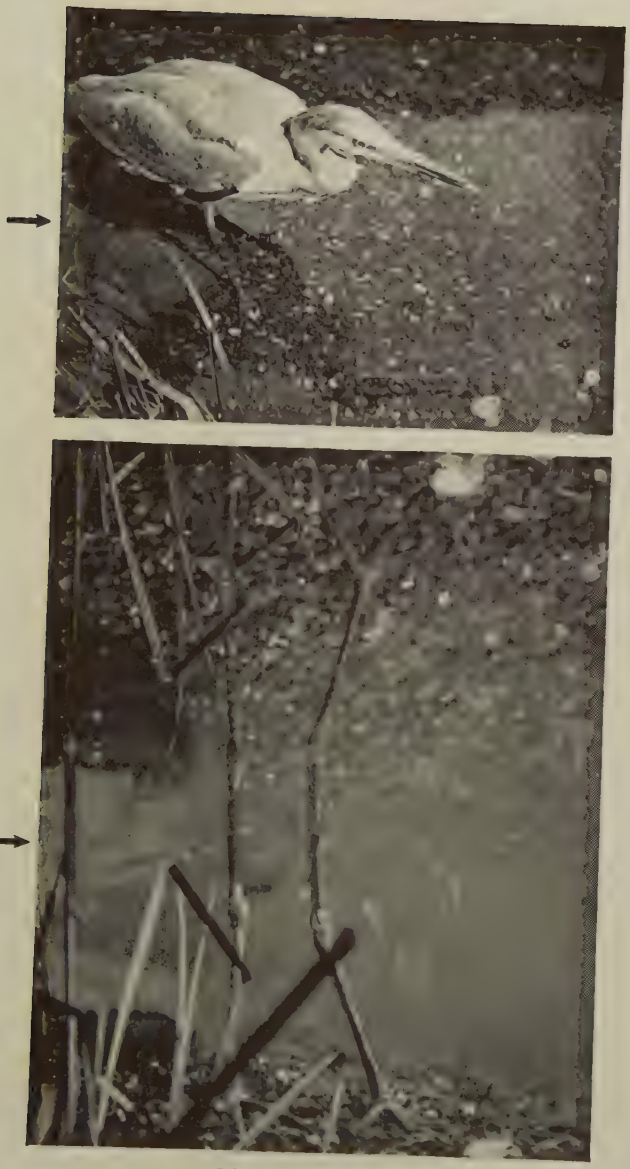
of the wader blends into this combined landscape.

When a bird stands in the water the observer below the surface sees the upper portion of the wader as described, but in addition he sees the legs in their true position under the water.

On the plate opposite a young heron is shown standing in a stream. The legs of the bird cut the water at the level of the arrow. The lower portion of the same plate shows how these legs appear to the observer under the water. An arrow again shows where they enter the water. All above this level is merely reflection from the surface.

I will next draw attention to the illustrations of the heron seen above the arc of the observer's "window."

On the plate opposite page 94 are three photographs. The first is a picture of one of my observation ponds, with a *stuffed heron* placed in the water. It is in the position assumed by a heron preparatory to striking a fish. On the right is shown the appearance of this stuffed bird seen from eighteen inches below the surface and at a distance of three



Heron Fishing.

Photographed simultaneously from above and below the Water.
(The Arrows mark the point at which the legs enter the water.
In the lower picture all above the arrow is merely a reflection.)

feet. The heavy dotted white line defines the arc of the "window"; a lighter line has been run round the compressed image of the heron. The adult bird has a dark patch of plumage on either side of the head and on the wings. These marks are shown in the photograph of the stuffed specimen. Seen from below, the black patches on the head stick up as two horns, while the light plumage on the top of the head blends with the grey sky beyond. Towards the right the back of the bird has an appearance similar to the tree-tops eighty feet away. On the left the dark wing-patch blends with the trees.

Next, without moving the bird, reeds were placed in the water seven feet behind. It will be seen how the dark markings on the head fit in with the pattern made by these reeds against the sky. This photograph represents exactly the appearance at dusk, and gives a fair indication of how the bird, the reeds, and the trees all appear to be on the same plane, and how the head and body of the wader are absorbed into the general pattern.

To get a better representation of the underwater view of the surface the reader should raise

the book above the level of the head, with the arms extended at an angle of forty-five degrees to the body, then twist the book until the photograph is in a horizontal position.

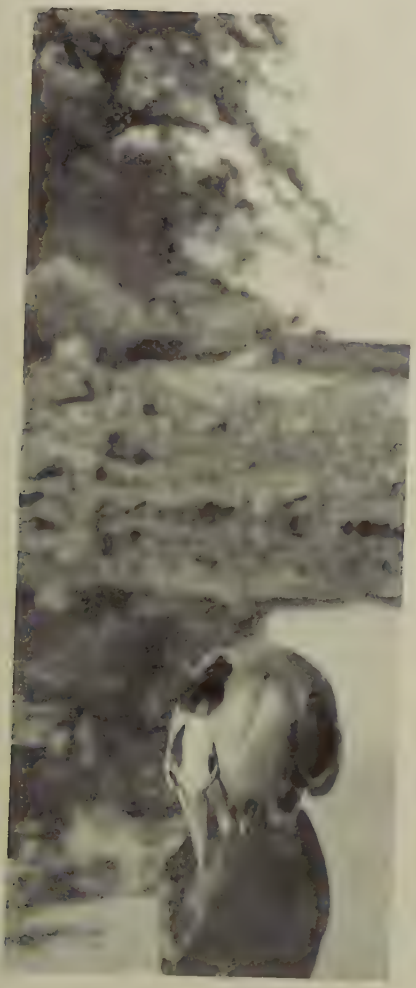
The surface of water beyond the arc of the "window" is dark because of insufficient photographic exposure. It is impossible to get a correct photographic exposure for the "window" and for the area of total reflection on the same plate in consequence of the bright light through the "window."

I have taken the heron as an example because of its bold plumage marks.

Waders that show less contrast are equally well concealed with rushes and reeds behind them.

Colour is also of value to the wader. In 1917 I watched flamingoes in the water at the mouth of the Wadi Guzzee in Palestine, and it struck me then how well the crimson of their plumage would blend with the ruddy sky which rimmed the "window" of an Eastern fish.

To return to the heron. If the bird is really concealed from the fish, as I have described, it should be possible for it to stand in clear water and catch as many fish as it requires. Provided that the fish are there and that the water is suit-



Heron as seen from above and below the Water.

able for wading, this is exactly what the heron can and does do. I will give examples of the numbers of fish taken by herons — numbers which it would be impossible for them to catch unless they were concealed from their prey.

On December 22nd, 1913, the late Mr. Hudson, of Ipswich, shot two herons on the Orwell, an adult and a young bird. In the gullet of the old bird he found one complete whiting, and later, when I examined the semi-digested contents, I found otoliths, lenses and bones, as shown on the plate facing page 96. Among the contents were seventy-six otoliths similar to those shown on the top row, which indicated that this heron had taken no fewer than thirty-nine whiting within the previous twelve hours. The next two rows are the eye lenses and vertebræ of these fish taken at various periods during the twelve hours. The bottom row shows otoliths triturated down from the sizes illustrated to a disappearing point. These were from whiting taken on the previous day. The young bird had taken thirty-one whiting. Both these birds came from a heronry in the middle of a wood on the banks of the Orwell.

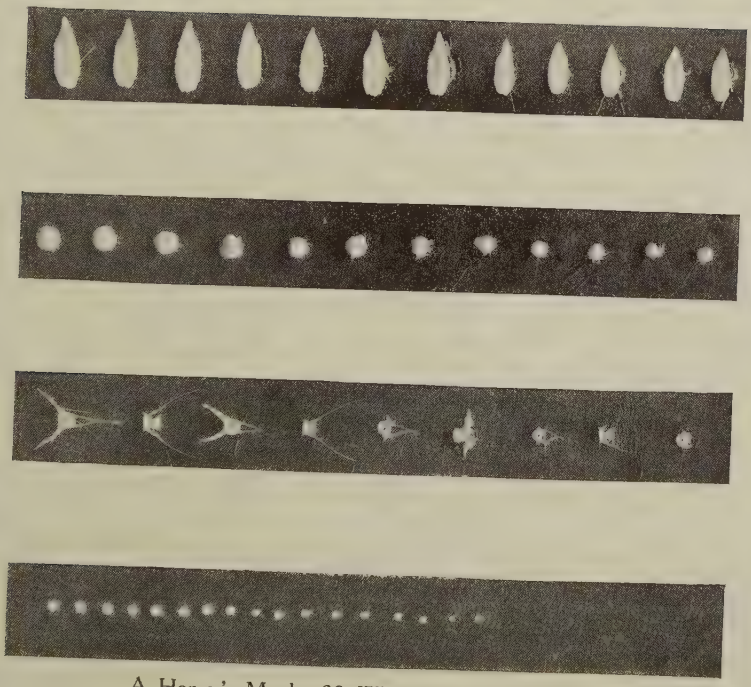
On one occasion, on a platform up in a tree,

I spent three days watching the feeding habits of the birds in this heronry.

Though the adult heron will devour rats, water voles, shrews, toads, frogs, shellfish, shrimps and young birds, the young at the heronry were fed almost entirely on fish.

The old birds appeared above the wood in April, and for several days wheeled round and round the tall tree-tops before they commenced to repair the nests used during the previous breeding season. Early in May each nest contained three, sometimes four, eggs. While the birds were sitting comparative peace reigned at the heronry. As soon, however, as the young hatched, the wood resounded night and day with the guttural notes of the old herons and the cries of the young as the parents returned to the nests from the fishing-ground. The fledglings were fed frequently, and I have seen a parent return with food eleven times within two hours. The older birds were fed early in the morning and again in the evening.

The fish brought to the young were mainly eels. A young heron only three weeks old was often given an eel of half a pound in weight. At first the parents regurgitated the



A Heron's Meal: 39 Whiting in One Night.

partly digested fish right down into the pouch of the young bird. Later the old heron brought up an eel, introduced the head into the gullet of its offspring, and then pushed it down inch by inch. Before the young herons fly the food is dropped into the nest from above, and they pick it up for themselves.

I made careful observations of the amount of food fishes taken to the young, and I also carried out experiments on the rate of digestion. The heronry consisted of fifty nests, and as a result of my observations I estimated that the young and old birds consumed forty-five tons of fish during the months of May, June, July and August.

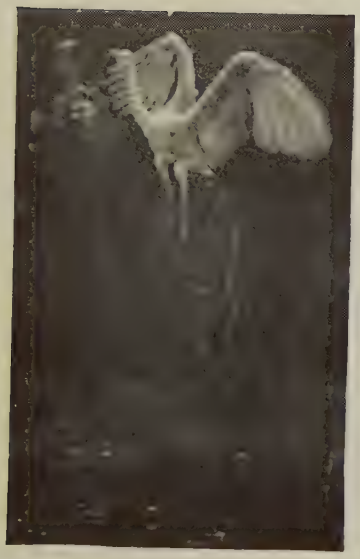
It seems to me quite impossible that herons should be able to catch anything like this quantity of fish unless they are invisible to their prey; but the ease with which this bird can catch the wily trout is conclusive proof to my mind that the heron *is* concealed from the fish.

Some years ago two friends and I stocked a stream near Ipswich. This stream was ten miles from the heronry described. When it was high water on the Orwell some of the birds flew over to the stream. On one afternoon I watched

a heron take three fish, then I crawled up and shot the bird. It contained seven trout over six inches in length—fish with which we had stocked the water. Eels and roach were also there, but it was the trout that the heron was specially after.

As a boy, my cousins and I, one summer holiday, caught several hundred trout in a mountain stream, and turned them into a shallow pond. Very soon we noticed a heron used to come down to the pond each evening. We thought it was probably after the trout, but never realised how this bird was taking out the fish as fast as we put them in. The pond was emptied soon after, and only three trout remained! Not only can the heron deceive small trout, but it is equally successful with large fish.

The question as to the extent of damage done to trout and salmon fisheries by herons has often been discussed in the Press. The amount of damage entirely depends upon the nature of the water. Herons will take trout whenever they get the opportunity. The time when they are most harmful, however, is during the spawning season. Many a trout too large for the bird to swallow has been speared by a heron as it struggled through shoal water on its way upstream.



Heron disturbed while Fishing.

CHAPTER V

GULLS

THE plumage of surface-feeding gulls is mainly white; sometimes the back is black or grey, and a few gulls have a black head, but the breast and abdomen are always white.

On the other hand, the skuas—which belong to the same family as gulls and terns—have a mottled-brown plumage. These variations in plumage conceal the various birds in the conditions under which they procure their food. That is to say, I consider the plumage of gulls as aggressive rather than protective.

When a white-breasted bird swims towards a fish its body is masked by reflection until it appears in the fish's "window." Opposite page 100 are two photographs of the lesser black-backed gull, and on the next plate the same bird is shown as seen from below the surface. Only a suggestion of the body of the bird can be detected. It is small wonder, then,

that the surface-swimming fish does not detect the approach of its enemy until too late. (This description, of course, merely applies to the appearance of the bird in the area of total reflection.)

When the fish looks upward he sees the head of the gull above the arc of its "window,"* when the head is white it is not easily detected against the sky. The best colour scheme, however, for a bird in this position is a white head and dark shoulders or a dark head and white shoulders. With the plumage marked in this manner, the compressed image of the head and shoulders of the bird appears as an interrupted broad line, and is lost in the "ripple pattern" round the edge of the "window." An illustration of this "ripple pattern" is shown on the plate opposite page 142.

How a black and white image is masked when seen above the arc of the "window" has been explained and illustrated in the chapter on wading birds.

In the case of the skua there is no necessity for a special arrangement of plumage to conceal it from the fish, as this gull lives by robbing others of the fish they have captured. The bird

*See lower illustration on folding plate facing p. 3.

Lesser Black-backed Gull seen above the Water.

is, therefore, coloured to conceal it on the rocks and shore, where it awaits the return of the fishing gull.

I have watched the lesser black-back and common gull feed upon my observation ponds, and from the behaviour of the fish I am certain that it does not detect the presence of the surface-swimming gull until the bird is almost over it—that is, within the fish's "window."

The lower photograph on the accompanying plate shows a lesser black-back plunging under the water after a fish. The gull was right over its prey before the little fish darted directly downwards.

Though, speaking generally, I consider the black and white plumage of gulls as a scheme of aggressive concealment, the same arrangement of plumage undoubtedly protects them from enemies below the water.

Reference has already been made to the fact that when an enemy approaches from below, its "window" narrows down so that a flock of gulls on the surface slip into the area of total reflection, and only the bird for which the predatory beast or fish is making remains as a dark silhouette against the sky.

During the observation of the fish-feeding habits of the gulls on my ponds I was very much struck by the rate at which they digest fish and the enormous quantities they will take. When an opportunity arose in 1912 of examining gull contents for an inquiry held by the Essex and Suffolk Fishery Board, I gladly accepted the invitation to examine these birds, in conjunction with the late Mr. Hudson, of Ipswich.

In this examination I was greatly assisted by friends too numerous to mention, but I would particularly thank Professor Herdman, Dr. Walter Collinge, and Mr. Howard, of Colchester, for helping me to recognise gull contents with which I was not familiar. By kind permission of the Essex and Suffolk Fishery Board, I have dealt with the information obtained during 1913-14 in a general manner. The detailed account of this work, with all the records, were submitted to the Fishery Department of the Board of Agriculture and Fisheries early in the war.

During recent years gulls have increased in such numbers that they are now present in their myriads round our shores, and the effect of sea-

birds on fish life has become an important consideration.

I have just read an article in *Country Life* of May 31st, 1919, entitled, "The Destruction of Sea-birds." The author writes: "In 1915 Dr. E. J. Allen stated, for many years past the total quantity and the total value of the fish landed in this country have both showed a steady and continuous increase. Ever since the year 1890, when the industry of steam trawling was already in full swing, the total landings have doubled, both in quantity and quality." The article continues: "During this period of thirty years there has been an enormous increase in most of our common sea-birds, and particularly so during the last ten or fifteen years, and yet, in spite of this, the numbers and value of the fish landed have steadily increased. We are, therefore, forced to one conclusion, viz. that whether these birds feed upon fishes or not, they have not appreciably affected the supply."

I have quoted this passage because, in one form or another, it typifies the argument which is always dished up by the biased bird protectionist.

This increase in our fish supply is, as a matter

of fact, due to the increasing numbers of large steam trawlers that go increasing distances to fetch fish, with an increased expenditure in fuel and labour, and proves nothing as to the effect of sea-birds upon the fisheries round our shores.

That our fisheries *have* been depleted is beyond question. To maintain a fish supply within reasonable distances of our shores, the waters for at least five miles round our coasts ought to be a nursery for food fishes, so far as man can make it. Instead of this, not even reasonable measures are enforced to control the irregularities of trawlers, no encouragement is given to the destruction of predatory fish, and gulls are allowed to increase in such countless numbers that they not only destroy an enormous quantity of food fishes, but have a serious influence upon the destruction of fish food round our shores and in the estuaries of our rivers.

When an endeavour is made to arrive at a decision upon the influence of gulls on fish life, the expression of opinion of the individual interested in fish must be ignored unless confirmed by an examination of the contents of the gull. I would not suggest that fishermen are

untruthful, but they are undoubtedly biased, and by acceptance of an unproved opinion a wrong estimate is formed of the fish-feeding habits of gulls. As an illustration, in 1913, in conjunction with a representative of a Fishery Board, I examined several gulls feeding in the sea off Bawdsey Ferry, near Felixstowe, and found them all glutted with sprats. Three days later a bird was forwarded to me with the information that the herring gulls were still feeding on sprats. The specimen, when shot, was plunging with a flock of one hundred birds into the water, over a sandbank. In view of the fact that these gulls were apparently fishing in a spot where, three days previously, we had found them full of sprats, it was not altogether unreasonable to assume that they were still feeding on fish. On examination, however, it was found that the specimen sent contained nothing but brittle stars, twenty of which had been recently captured, and therefore were comparatively whole. Broken portions of several others indicated that the complete "catch" was considerably larger.

The brittle star is a starfish injurious to fish life, and if the other birds in the flock were feed-

ing in a similar manner they were doing most useful work.

On another occasion, at the invitation of a representative of the Essex and Suffolk Fishery Board, I went to the River Alde, where the black-headed gulls were described as plunging *below the water* after fish. These birds certainly did disappear below the surface, but when examined they were found to be full of shrimps (*Crangon vulgaris*).

Again, gulls have often been examined in the vicinity of fisheries, and it has been found that here they merely pick up the fish thrown overboard, and really act as scavengers.

On the other hand, the fact that a gull does not contain any apparent traces of fish when examined is no indication that it has not devoured several during the day. Even a small bird, such as the black-headed gull, can digest a six-inch fish within four hours so completely as to leave no trace of it throughout the alimentary tract. Further, gulls are omnivorous and voracious feeders, and often exceptional feeding habits are quoted as evidence of the good or bad influence they have on fish life, agriculture, etc.

Before I give the results of the examination of the contents of 650 sea-birds, I would like to add a few points which have come to my notice during this examination.

In estimating the amount of fish destroyed by gulls it is necessary, as I have already suggested, to take into consideration the rate of digestion in these birds. I have carried out several experiments in this direction, and give the following as an example of the results obtained :

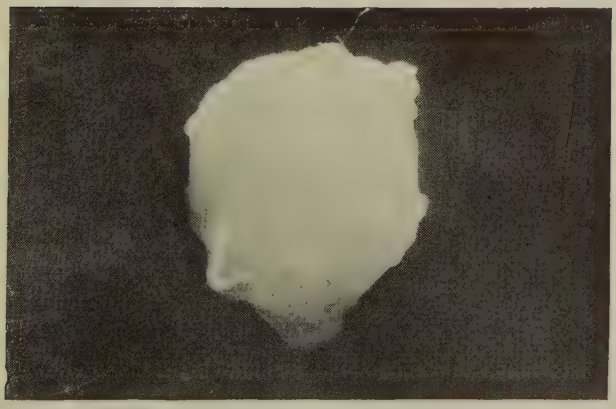
For many years the refuse collected from a suburb of Ipswich was dumped on a farm adjacent to my house. During the winter months a flock of over two hundred black-headed gulls and a few common gulls stayed on the farm, and whenever the sanitary carts arrived these birds swooped down on the refuse and picked it over, after which they rested or scattered on the fields until the carts reappeared. On December 13th, 1913, I commenced to feed them each morning with two or three pounds of sprats. The fish were thrown down in a field adjacent to the refuse dump, and about sixty feet from a cowshed. In a day or two the gulls looked for this meal, and a few seconds after

the sprats were thrown out not one was left. After feeding the birds in this manner for a week, I prepared a test meal of two hundred sprats. A small hole was made in each fish, and a few grains of methylene blue inserted—no sprats of less than five inches in length were used.

At 8.10 A.M. on December 22nd these prepared sprats were thrown down and taken as usual. At 11.5 A.M. more sprats were thrown out, and as the gulls flocked round seven were shot by gunners concealed in the cowshed, and secured before they could disgorge. Six out of the seven had taken prepared fish, as proved by the fact that the contents of the birds were stained an intense blue.

On the plate opposite is shown the material found in the first specimen. The first five rows represent 53 water snails; the sixth and seventh rows, a piece of coal and 22 stones; the eighth, ninth, and half the tenth row, greasy material, debris, and blades of vegetation. The last eight objects in the tenth row represent all that remained of a sprat taken three hours previously. These are mainly the remains of a few vertebræ, but the globular object fourth from the end calls

Natural Size.



Air Vesicle magnified 15 diameters.

Stomach Contents of Black-headed Gull.

for special attention. It is shown, magnified fifteen times, on the lower half of the plate. This globular object, the size of a small millet seed, is a hard, bony vesicle which floats in water. The presence of this vesicle inside a gull is certain evidence that the bird has fed on a member of the herring family during the day —in this case a sprat.

My attention was first drawn to these bony vesicles in the following manner: My procedure when I examine the contents of a gull is to remove the entire alimentary tract, then open the gullet and gizzard, and pick out the larger objects; the remainder of the tract is then cut open, and the whole washed out in a basin of water, filtered, and examined, if necessary, under the microscope. While I was examining the contents of kittiwakes which had been following up shoals of sprats off the East Coast, I found these hollow globules in large numbers. Next I boiled the skulls of sprats, and rubbed the softened bones between the finger and thumb, and obtained a pair of these globules with each skull. This is exactly what happens in the gizzard of the gull; the bones are softened by the gastric juices, and in the gizzard the softer

bones are triturated away, while the denser bone round an air space on each side of the skull remains.

An air space on either side of the skull, surrounded by dense bone, suggested some arrangement in connection with the sense of hearing. I therefore sent some vesicles, with notes, to Professor Herdman, and received the following answer: "Dr. Johnstone has just dissected out the head of a sprat, and finds that the vesicles are the anterior end of an extension of the air bladder to the skull; they are what are known as 'the anterior air vesicles,' and were described by Duncan Matthews in the Scotch Fishery Board Report, Vol. V., in the 'eighties."

To the reader who is not conversant with fish anatomy, I would explain that in most bony fishes there is a swim bladder under the backbone, which is filled with gas. In the herring family a fine, tube-like prolongation extends from this bladder to the air space described. Vibrations in the water which reach the sides of the fish affect the swim bladder, and are conveyed by this extension to the air vesicles. As these air vesicles are in the region of the brain, the vibra-

Stomach Contents of Black-headed Gull.

tions are appreciated as sound, and in order that the anterior air vesicles may make a better sounding-box, the bone around has become denser.

It is this harder bone that resists the triturating action in the gizzard of the gull long after the softer bones have disappeared. As stated, the presence of a bony globule floating on the surface when the contents of a gull are washed out is a sure sign that the bird has taken a member of the herring family during the day.

To return to an examination of the contents of the six other black-headed gulls that had taken blued sprats. The second bird contained sixteen spicules of bone, the remains of almost digested vertebræ and two air vesicles. The third and fourth birds revealed fish in the gullet, as shown on the plate opposite page 110. The fish had been rendered soft and pulpy by the gastric juices, and fell to pieces in the fingers—each fish contained methylene blue. The explanation in the different rate of digestion is as follows: In the first two birds the gizzards were empty when they took the prepared sprats, and so the fish passed down to be triturated; but the third and fourth birds had fed on the refuse heap before

taking their fish meal, and their gizzards were, respectively, filled with tea leaves and greasy material; the fish, in consequence, could not enter the gizzard to be triturated.

The fifth bird contained nine almost disappearing bodies of vertebræ, one whole and one broken air vesicle.

In the sixth bird both gullet and gizzard were absolutely empty, but the gut was full of blue material.

The last bird, as stated, had not taken a blued sprat.

Other experiments which I have carried out have confirmed this rapid rate of digestion.

With some of the large gulls, e.g. the great and lesser black-backed, evidence that the bird has taken a fish is removed even more rapidly, for towards the end of digestion these birds disgorge the bones remaining in the gizzard. Large colonies of lesser black-backed gulls nest on the island of Rona, and the ground is covered with collections of disgorged bones.

In the wild state a lesser black-backed gull can digest a pound codling in four hours, so that when the remains of the triturated bones are

thrown up, nothing is left to show that the bird has fed on fish.

From what I have written it will be realised that the rate of digestion in gulls must be allowed for when one considers their influence on fish life.

The presence of otoliths, or ear bones, in the gizzard of a gull is also a means of estimating the number of fish taken by this bird. In many bony fishes there is, on either side of the base of the cranial cavity, a sac which contains an otolith, or ivory-hard ear bone. The margins are indented and the surface is grooved. In these grooves are lodged the terminations of the nerves connected with hearing.

Otoliths vary greatly in size and shape, but they are distinctive in various fish. In consequence of their hardness they resist the triturating action in the gizzard of the gull, and remain long after the soft bones have disappeared. Speaking generally, an average-sized otolith is rendered quite smooth and very much diminished in size in twelve hours, and has disappeared in twenty-four.

I will now give an example of the value of otoliths and the air vesicles described in estimat-

ing the real numbers of food fishes destroyed by gulls.

In December, 1913, my brother and I stayed at Aldeburgh, and on one morning examined four birds in the bay. The first was a kittiwake; in it there were nine recently taken sprats in the gullet, and the gizzard contained the bones shown in the first row on the plate opposite. These are portions of two whiting otoliths, seven bony globules, and the bodies of four vertebræ. The margins of the otoliths were still indented, so that we could be quite certain this kittiwake had taken a small whiting and four sprats earlier in the day in addition to those in the gullet.

The second kittiwake examined was an immature bird, and had three sprats in the gullet, and among the debris in the gizzard were whiting otoliths and bones, as shown in the second row, indicating that the bird had taken these fish recently.

The third and fourth birds, a kittiwake and a common gull, when shot, hung their heads under the water and continued to swim, a sure sign that they were disgorging. The gullets of both these birds were, in consequence, empty;

but the gizzards contained the bones shown in the third and fourth rows, which read respectively: a whiting earlier in the day, and a whiting and sea urchin the day before; the second bird, two whiting and four sprats. That this last bird had recently taken fish which it had disgorged is proved by the two vertebræ, which show complete processes.

To arrive at an estimate of the fish that the gulls were taking in Aldeburgh Bay on that morning, I have argued as follows: Two contained twelve fish, two disgorged; it is fair to presume these latter had taken an equal number of fish. From the otoliths and bony globules found, we can be certain that the four had taken twelve food fishes earlier in the day—that is, a total of thirty-six whiting and sprats by noon. The flock of gulls in Aldeburgh harbour following up the sprats was certainly not less than 20,000 in number, which gives an estimate of 180,000 food fishes taken by noon. Gulls were feeding in a similar manner all round the east coast at this time.

How easy it is to miss a fish taken by a gull earlier, and subsequently followed by other food, is shown on the lower half of the same plate,

which is a photograph of the contents of a gull after a miscellaneous meal: three starfish (five inches across), three hermit and two shore crabs, one sea anemone, five whelks, earthworms, and, earlier in the day, a whiting, as shown by the two otoliths mounted on a piece of black paper. Everything is quite apparent in this illustration, but in the alimentary tract of the bird the whole is mixed up in a semi-digested odoriferous mass, in which small otoliths may easily be missed.

From the foregoing remarks it will be appreciated that to estimate the amount of fish taken by sea-birds it is necessary that the observer should have considerable knowledge of fish life, and even then, unless a liberal allowance is made for the rapid digestion of gulls, the damage done to our fisheries will be very much underestimated.

In 1912 complaints were received by the Essex and Suffolk Fishery Board concerning the damage done by gulls to the fishing industry on the Suffolk coast. A committee of inquiry was formed, and during 1913-14 I examined the contents of 54 divers, 575 gulls and 22 nestlings. At first only birds obtained locally were

examined, but, as the results differed considerably from what was expected, the examination was extended to twelve stations round Britain, in order to check the local findings. Gull contents were examined continuously from January 1st, 1913, to June 16th, 1914. My brother (Colonel Ward) and I also spent ten days on the deserted island of Rona, in order to observe the feeding habits of gulls uninfluenced by the methods of man.

In giving the result of this examination I will endeavour to group it so as to throw some light on the three following questions:

1. What influence have gulls upon the fisheries round our shores?

2. What influence have gulls upon our inland fisheries?

3. Presuming it is acknowledged that gulls do a certain amount of damage to our fisheries, is this outbalanced by the benefit they confer on the agriculturist by the destruction of injurious insects?

I have described the destruction in a single morning by flocks of kittiwakes and common gulls in Aldeburgh harbour, but this is obviously

a particular instance, and no indication of the feeding habits of gulls in general.

During 1913 456 gulls were examined throughout the year. The birds were collected where the majority are to be found—viz. along the seashore, ten miles up the estuaries of rivers, and two or three miles out to sea.

Of gulls shot in these situations, the great black-backed, lesser black-backed, kittiwakes and terns were found to feed mainly upon fish, and evidence of *food fishes* were found in 60, 30, 83.5, and 50 per cent. of these birds respectively at the time they were examined.

From what I have written it will be realised that a considerably larger proportion had taken fish during the day. The contents of lesser black-backed gulls on Rona showed a very much higher percentage of fish.

That these birds take enormous numbers of fish is not denied, neither is it contended that they benefit the agriculturist. This is, however, not the case with the herring, common, and black-headed gull; 82, 92, and 167 of these birds respectively were examined during 1913-14 in the situations I have described, and opposite is a table of the contents found:

	Herring Gull.	Common Gull.	Black-headed Gull.
	Per cent.	Per cent.	Per cent.
FISH			
Of all varieties present in .	18.2	24.5	28
Useful as human food . .	10.4	17.5	13.5
Useless as human food . .	7.8	7.0	14.5
MARINE FOOD OTHER THAN FISH present in the following percentages:			
Shrimps (*Pandalus annulicornis* and *Crangon vulgaris*)	5.2	14.6	27.0
Lugworms (*Arenicola marina*)	—	2.4	7.6
Ragworms (various *polychæta*)	—	3.7	6.7
Molluscs	7.8	3.7	4.8
Small crustacea . . .	2.6	2.4	8.5
Crabs (various shore crabs) .	16.9	7.3	7.7
Echinoderms—			
Starfish, brittle stars, sea urchins . .	18.2	—	—
Whelk-spawn (*Buccinum undatum*) . . .	10.4	—	—

It will be seen that food fishes were not present in so large a percentage of these birds, and even if one-half were missed—due to the rapid rate of digestion—it is evident that not one in four of the gulls had taken a food fish during the day. Human food, such as edible molluscs and shrimps were present in a fair percentage, but the destruction of fish food was very considerable. To illustrate the influence of gulls on fish food, I give one example.

Near Ipswich, on October 10th, 1913, nine gulls were shot whilst feeding in a small creek on the River Orwell opposite Pin Mill. They were all found to contain fish and crustaceans—i.e. shrimps (*Crangon vulgaris*).

With every low tide the gulls feed in the shallow water of the creeks on the Orwell. On one occasion a flock of approximately 160 gulls in one situation, and another flock of over 200 a little below them, were feeding and fighting for food. Nine black-headed gulls were obtained at one shot from a punt gun. One had evidently just joined the flock, and only contained blennies and earthworms. Two others were not shot dead and disgorged large quantities of shrimps, but the six gulls shot dead contained 297 shrimps in all—an approximate average of fifty shrimps for each bird. These two flocks, therefore, probably contained over 17,000 shrimps, and the water was still one hour before low tide. One gull which contained 75 shrimps was nearly full up, and 15 more would probably have completed the meal, and the gull would have flown ashore to digest. We may thus fairly allow 90 shrimps as the average number a gull would hold, and on this estimate these two flocks would probably

devour over 30,000 shrimps on that tide. As there were over 2,000 gulls feeding in the Orwell at this time, it may reasonably be assumed that 100,000 shrimps were accounted for.

The Orwell used to teem with fish; it now teems with gulls after fish food in the tidal water.

The fishing round our shores and in the estuaries of our rivers has certainly deteriorated, and after the facts I have given it appears to me reasonable to think that gulls are to some extent responsible for this deterioration.

The next question is, what is the influence of gulls upon our inland fisheries?

I have by me at the present time a book full of correspondence, press cuttings and reports concerning the fishing habits of gulls on inland waters. The fisherman seems to have no doubt whatever in his mind as to the depredations of the common and black-headed gull, and I had found trout in black-headed gulls before I examined birds during the investigation I have mentioned. I have no data of these bygone days, but during 1913-14 I examined the contents of thirty-nine black-headed gulls shot in the vicinity of a stream near the Solway Fishery, Dumfries, and near the Rothesay Fishery,

Bute : trout (*salmo fario*) were found in 64 per cent. of the birds, one specimen contained nine trout, from 2½ to 4 inches in length, and several fish of 6 inches were taken.

Of eighteen common gulls shot in the same vicinity 44.6 per cent. contained trout from 5 to 7 inches in length.

In the Summer Number of *Country Life*, June 7th, 1919, there is an article "A New Colony of Black-headed Gulls." The photographs which accompany this article are beautiful pictures by Arthur Brook. If Mr. Brook is also the author of the text he has exactly hit off the habits of the bird about which there has been so many complaints. These are the words of this ardent bird observer : "When the black-headed gull leaves the pond" (breeding grounds) "it does not at all follow that it wings its way back to its seaside haunts. On the contrary, it takes very readily to the moorland, where the stream provides as much food as the sea itself." Mr. Brook then describes how gulls fish upstream so as to avoid being detected by the wary fish. "The gull, on a beat of a mile or so, comes up as warily and vigilantly as a good angler, and when he reaches the end of his beat departs over

the shoulder of a hill so as to be out of view, and resumes his quest at the point at which he originally started."

The angler fishes occasionally, the gull persists *daily* in these manœuvres from dawn to dusk until the trout have been cleared out of the stream.

What is the good achieved by gulls to counter-balance the damage they do to fish?

The larger and mainly fish-feeding gulls, as already described, do not enter into this consideration, for they feed very little upon the land. The herring, common and black-headed gulls, however, take a considerable amount of land food, and below is a table on the land feeding habits of 82 herring, 92 common, and 167 black-headed gulls compiled at the same time as the table on page 119.

	Herring Gull.	Common Gull.	Black-headed Gull.
LAND FOOD	Per cent.	Per cent.	Per cent.
Earthworms were present in	6.5	18.5	18.3
Wireworms „ „ „	.0	.0	3.8
Beetles . „ „ „	1.3	1.2	9.6
Craneflies . „ „ „	1.3	11.0	5.7
Other Insects „ „ „	1.3	8.5	3.8
Cereals . „ „ „	19.5	11.0	2.9
Garbage . was „ „	11.7	13.4	3.8

To commence with the herring gull; earthworms were present in 6.5 per cent. of the birds. No wireworms were found in all the 86 birds examined, only 4 per cent. had taken any insects at all. On the other hand, cereals were present in 19.5 per cent.—that is to say, of 86 herring gulls shot round our shores throughout the year every fifth bird contained grain.

When a herring gull feeds on grain he does not take it as does the sparrow, but in large quantities. On the plate opposite are the contents of a single herring gull shot on September 11th, 1913, at sea near Padstow. This bird had taken 140 grains of oats, and 460 grains of wheat.

In September and October, 1913, herring gulls were known to be taking grain near Padstow, and in the table below is given the contents of eight birds shot at sea about a mile from land.

Sept. 11th	At sea near Padstow	40 grains wheat, otoliths and fish bones.
„ 11th	„ „ „	140 grains oats, 460 grains wheat.
„ 30th	On the shore near Dumfries	30 grains oats.
Oct. 10th	At sea near Padstow	250 grains oats, larvæ craneflies and earthworms.

Stomach Contents of a Herring Gull: 140 grns. Oats, 460 grns. Wheat.

Oct.	21st	At sea near Padstow		24 grains growing wheat with root and blades.
„	21st	„	„	„	20 grains growing wheat with roots and blades.
„	21st	„	„	„	4 grains growing wheat with roots and blades.
„	21st	„	„	„	2 to 3 grains growing wheat with roots and blades.

The result was so extraordinary that in December of the same year six herring gulls were shot on wheat fields in the same area. One bird was empty, the other five all contained roots and blades of young growing wheat. In one specimen the bird was full from beak to crop and must have contained many hundreds of shoots.

This material was sent to Dr. Walter E. Collinge for confirmation, and his report is as follows: "I have carefully examined the contents of the bottle and find a little grass, part of the body of a slug (*Agriolimax agrestis*, *L.*), a little grit, but the bulk of the material is the remains of wheat."

Mr. Stavely, of Rothesay, describes the herring gull as sitting on the sheaves and feed-

ing on oats; a specimen shot contained evidence to prove this.

The herring gull would therefore appear to take cereals at all seasons.

This sea-bird certainly cannot be considered to be the farmer's friend, and his land feeding habits do not help to atone for the destruction of fish caused by gulls in general.

An examination of 92 common gulls showed that 18.5 per cent. had taken earthworms, but again not a single bird contained a wireworm; 20.7 per cent. had taken insects, one-third of which may be considered beneficial to the farmer; 11 per cent. had taken cereals.

Though the great majority of common gulls are to be found round the shore and on estuarine waters, at certain seasons considerable numbers fly farther inland to feed. Here, though they do some benefit by the destruction of injurious insects, this would appear to be outweighed by the damage done to cereals. Thirty common gulls were examined between December 4th, 1913, and March 4th, 1914. All these birds were shot while following the plough in the vicinity of winter wheat, or recently sown

land. The specimens were collected in Cornwall, Suffolk, Linlithgowshire and Bute.

The total contents of the thirty birds were as follows:

638 recognisable earthworms, besides a mass of worm pulp.

14 Wireworms.

3 Flies—Diptera.

2 Chrysalid goat moth.

2 Larvæ cockchafer.

1 Earwig.

1 Grasshopper.

1 Hen's egg.

Recognisable food fishes were present in eight birds.

Garbage in three birds.

Forty per cent. contained cereals, consisting of seed, germinating seed, young plants and rootlets of wheat and oats.

From this it will be seen that the land-feeding habits of the common gull can hardly be considered so beneficial to the farmer as to outweigh even the damage that this bird does to fisheries on inland waters.

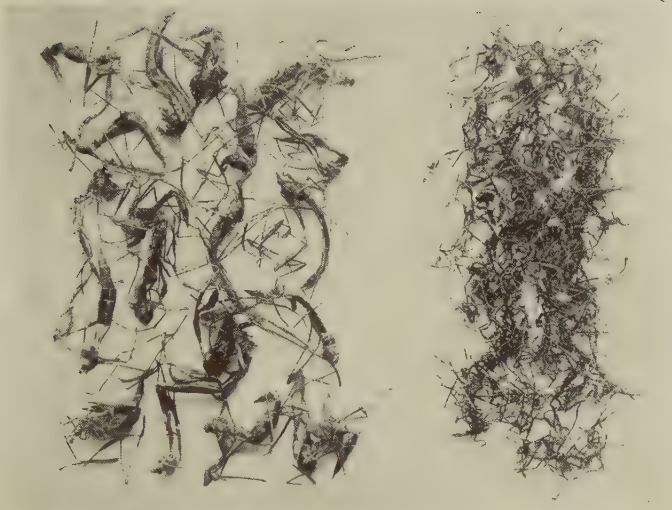
The black-headed gull has been considered to be the farmer's friend, but the good he does by

no means compensates for the injury done by this gull to fish life.

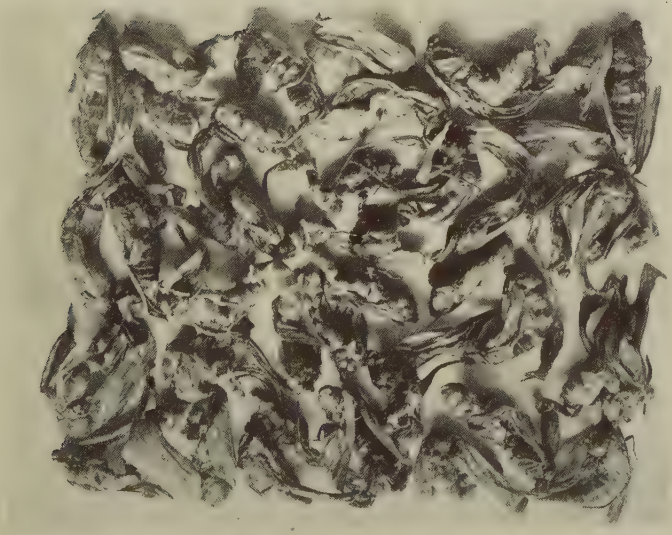
Of the 167 black-headed gulls shot at sea, along the shore and in the estuaries of rivers, it will be seen that 18.3 per cent. contained earthworms, 3.8 per cent. wireworms, and under 20 per cent. insects of any sort, of which again a third may be considered beneficial. In the matter of cereals, grain was only found in 2.9 per cent. of all the birds examined.

But it may fairly be argued that the benefit conferred on agriculture by the black-headed gull can only be judged when the birds feed inland.

Under exceptional circumstances, and at special seasons, these birds unquestionably do destroy large numbers of injurious insects, and on the plate opposite are shown the contents of two black-headed gulls which leave no doubt as to the usefulness of the flock with which these birds were feeding. But, on the other hand, in 1906-7 at the request of the Cumberland County Council, Mr. D. Lush Thorpe, M.B.O.U., and Mr. Linnaeus Hope, examined 100 black-headed gulls. Of 25 birds examined in April 45 per cent. contained cereals (oats) with as many as 100 grains in a bird.



Crane Flies.



Ghost Moths.

Stomach Contents of Black-headed Gull.

The black-headed gull is supposed to do an immense amount of good when following the plough by destroying wireworms and other injurious insects.

Of thirty specimens shot following the plough between December 4th, 1913, and March 4th, 1914, the total contents were as follows:

747 Recognisable earthworms.

5 Beetles.

1 Earwig.

No wireworms.

Food fishes were present in two birds.

Eight per cent. contained cereals.

These birds certainly were not helping the farmer, and in heavy land where the worms are useful for improving drainage they would be doing harm.

Nobody who has any experience of inland streams and lakes will deny that the black-headed gull damages the fishing, and in dry seasons when the water is low that this damage is serious. It appears to me that even when feeding on the land, the good that this bird does by the destruction of injurious insects is outweighed by his bad habits, and he certainly does not atone for the sins of the gull tribe.

CHAPTER VI

THE KINGFISHER

IN some of the older writings on natural history the kingfisher is described as a bird that builds a nest, consisting of fishbones, in the hole of a water-rat, which is enlarged and altered to the liking of the bird. Some more modern writers state that the kingfisher uses the nesting-hole of a sand-martin.

I have seen a great many burrows, at the end of which kingfishers have reared their young, but I have never in a single instance met a case in which the bird had used the hole of a water-rat or the disused excavation of a sand-martin!

Kingfishers pair in April, and are frequently known to return to a hole in which they have nested before. On the Chantry Pond, near Ipswich, a pair successfully reared three consecutive broods in the same hole.

When a new burrow is to be made, the bird often begins at a point where a stone has fallen

out of a sandbank or where there is some other irregularity on which it can get a foothold and a starting-off place for its digging operations. Failing this, the bird will make this first foothold for itself in the following manner: From a distance of about six feet the bird flies, from the ground or from an adjacent branch, straight at the sandbank, driving its bill well into the sand; it then drops, and the bill, acting as a lever, forces out an appreciable quantity of sand. The process is repeated several times, the bill being driven into the right spot with absolute precision. Ultimately a good foothold is obtained. The bird now commences to dig with the beak, while the feet are used to throw out the sand behind it. Examination of a burrow will generally reveal beak-marks all along the roof and sides, right to the end of the burrow. As soon as the excavation is large enough, both birds work in the nesting-hole at the same time.

The hole itself is about two inches in diameter, and is usually made a foot or so from the top of the bank. It extends for about two feet into the bank, but when the sand is soft a burrow may be nearly three feet in length.

The eggs are usually laid at the end of the completed burrow within thirty days. Should the first nest be destroyed, the birds will work much faster at a second, and complete it in far less time, and all is ready for the commencement of incubation, within seventeen to twenty-one days.

Naturalists appear to differ in their opinions as to whether a kingfisher deliberately uses fish bones to form a nest or whether the presence of fish bones at the end of a burrow is purely accidental, and that they are merely from the pellets thrown up by the nesting bird.

Personally, I think the latter is the more probable explanation of their presence. Mr. Ridley, a Lancashire naturalist, has, however, described how, on one occasion, pellets were left along the ridges on a sandbank where kingfishers were digging. After a time these pellets disappeared, and when he examined the nest he found two eggs, with large quantities of fish-bone pellets—far more than it was possible for the birds to have thrown up during the short time that they had occupied the nest. Mr. Ridley was of the opinion that these birds, before laying their eggs, had carried the pellets

A Fish.

The Dive.

deposited round the hole into the end of the burrow.

The number of eggs laid is almost invariably seven; more are quite exceptional, but it is possible that there may be only six.

It is usual to think of the kingfisher as a fish-feeding bird, which is invariably found by the waterside. The kingfisher family, however, which consists of over one hundred and fifty species, is divided into water-kingfishers and wood-kingfishers. The former are found by shady brooks, and mainly live on small fish, though, in addition, they take a certain number of insects and crustaceans. Wood-kingfishers dwell in forest regions, not necessarily by water. Their food consists of insects, reptiles, crustaceans, with, occasionally, small fish.

Of all kingfishers there is none more beautiful than the brilliant little blue bird so familiar in every secluded brook and stream at home. This kingfisher (*Alcedo Ispida*) has a wide distribution throughout Europe, Asia, and Africa. During the spring and summer a few pairs may be found nesting on every stream, but in some parts they are quite numerous. I have, for instance, found fifteen nests within

ten miles on the banks of the Lancashire Hodder.

In October there is a partial migration, and it is at these times that the kingfisher feeds on crustaceans along the seashore.

In the autumn of 1917 I saw large numbers of these birds at the mouth of the Wadi Guzzee, before Gaza. They were perched upon rocks along the shore, and every now and then one would leave the rock, hover like a hawk over the breaking surf, and then dive, to come up with food in its bill.

Shallow water, swarming with small fish, flowed through the last three miles of the Wadi, and here kingfishers perched on the military telephone wires over the water. A wire is a most unsuitable perch for a kingfisher, and each time a bird dived from the telephone wire it appeared to lose its balance and failed to catch its fish.

The kingfisher catches its fish in several ways. It may dive, with closed wings, straight down off a branch on to a fish immediately below; it may fly at an angle, and close its wings just before it enters the water, like a gannet. When the water is very shallow, or

Got Him !

Gone.

The Kingfisher.

the fish near the surface, the bird uses its wings all the time, and swoops down on its prey like a surface-feeding gull. In these circumstances the flight is continued for the short time that the bird is under the water. Again, the kingfisher often leaves its perch and hovers over the water like a kestrel. The tail is depressed, and the head is bent forward so that the beak rests on the breast. Suddenly the bird tips up and drops like a stone on its prey. This appears to be the most successful method of fishing.

As soon as the kingfisher, sitting on a branch, sees a fish below, it immediately becomes alert, all its feathers are tightened, and it anxiously watches the approach of its prey. This attitude is illustrated in the photograph opposite page 132. The second illustration on this plate shows the flight of the bird into shallow water.

This photograph was taken at the exposure of one-thousandth part of a second, and the expanded wing of the kingfisher is visible in the centre of the splash.

The next two illustrations show the same bird back on the bough with a three-inch rainbow trout, seized by the head. The fish was

then banged on the branch, turned, and swallowed head first.

Before a kingfisher attempts to turn or swallow food it invariably knocks it upon its perch. It is very unlikely that the bird objects to swallowing the food alive, and the probable reason why the fish is first knocked on the perch is to prevent it escaping while it is being turned and swallowed. Young kingfishers, by instinct, bang all their food in this way.

On one occasion I reared a nest full of young birds, which lived for several weeks in a special cage fitted with a diving tank. Fish food was not always available, and occasionally they were fed on small pieces of raw meat. In one case the young bird pierced the meat with its upper bill, and was, in consequence, unable to swallow it. Each failure to get the piece of meat down was followed by a series of bangs. After I started to count, the fledgling hit that piece of meat one hundred and forty times before it broke away from the beak.

I next tried a lump of cold porridge. Two bangs, and the porridge was gone! The bird evidently thought that the porridge had escaped, and was determined to kill the next piece with

Kingfisher: Repose after a Meal.

a really good bang, with the result that this time it all disappeared with the first knock.

However plentiful food may be in the vicinity of a nest, the parent kingfisher always flies to some distance to fish. Here it usually selects a bough overhanging a shady pool, and time after time returns to exactly the same position on that bough. This perch is usually at a height of from six to ten feet above the water. From this position the bird can spot small fish at a considerable depth.

On trout waters, where minnows are plentiful, the kingfisher does little harm, for minnows are easier to catch than trout fry. On fish hatcheries, however, this bird, like the dabchick, can do an immense amount of damage in a very short time.

CHAPTER VII

THE ANGLER AND HIS LURES

SIR HENRY CUNYNGHAME, in the *Fishing Gazette* of April 27th, 1912, was the first to describe the appearance of the floating fly, as seen from under the water. In *The Field* of May 3rd, 1912, I illustrated several experiments with trout and salmon flies. These experiments were carried out in a controlled stream, and the observations were made from a chamber built into one bank.

A year later, also in *The Field*, I illustrated the appearance of the angler seen from under the water. This article was followed by a considerable amount of correspondence, which dealt mainly with the optical explanation of the appearances described. I would refer those interested in this subject to the Spring Number of *The Field*—1913.

In the present chapter I will deal merely with the fisherman and his methods, as seen from

below the water. If an observer under the water were to look forwards and slightly upwards, he would see, on the surface, the arc of his "window" and an area of total reflection beyond.

When a fly is thrown over him from behind, he sees: a break in the area of total reflection and a flicker of light as the fly strikes the water. When the fly has settled, only the body, hackle, and hook are visible, with a reflection of the same from the surface. The gut from this point to the edge of the "window" is difficult to detect. The wings are visible above the arc of the "window," in the same way as the sail of the boat is seen in the lower illustration on the plate opposite page 3. Across the "window" itself the gut, whatever colour, shows up as a clearly defined dark line.

As the fly floats down towards the observer, the image of the wings becomes larger and more distinct. The body of the fly next passes through the ring of rainbow colours round the circular "window" and blends with the image of the wings. The fly is now seen as a whole, within the "window," as a dull silhouette against the sky. In this position the general

form of the fly can be appreciated; there is a suggestion of colour about the wings, and a slight iridescence round the hackle. Along the side of the body there is frequently a streak of light, particularly if paraffin has been used.

The foregoing is a description of what is seen by the human eye. A fish as compared with man is short-sighted, and its behaviour, as observed from under the water, suggests that it does not appreciate the fly until it is seen as a whole within its "window." Here the fly appears as a blurred object, and the fish goes up to have a look at it. If on nearer inspection the fly gives satisfaction, it is taken.

This inspection opens up another consideration, viz. though the angler may not be visible to the fish when the fly first comes into its "window," he becomes so with the altered position of the fish.

Opposite are two illustrations representing the surface of the water as seen from below. Hold the plate in a horizontal position above the level of the head, as before. In the lower photograph the blurred image of the fly has just come into the "window." Beyond, the stones on the bottom of the stream are reflected from the sur-

Dry Fly as seen by a Trout.

face. This is what the fish sees as he swims in a horizontal position.

Scores of times has the dry fly-fisher seen the trout come up to his fly, refuse, and sink back to the spot from which he came. The fish may do this once or twice, and subsequently ignore the artificial fly as it passes over him, but he may still continue to rise to the natural fly. The trout is not frightened by the artificial fly, he simply recognises that it is not what he wants and so ignores it. On another occasion a fish may come up to a fly thrown in the same manner. This he does not refuse, as described above, but suddenly turns off and disappears. I think the explanation is that, on this occasion, the angler has come into the fish's "window" in consequence of the altered position of the fish in the water. The top photograph on the plate opposite page 140 illustrates this point. The moral for the fisherman is to keep well down, even when below the fish, unless concealed against a suitable background.

The under-water appearance described up to this point only applies when the surface of the water is still or moving gently with an unbroken surface.

A ripple caused by a breeze will help to conceal the angler to a very considerable degree. When the surface of the water is disturbed, dark, dancing ripple lines encroach upon the "window" all round and diminish its size. These lines are seen in the first illustration on the plate opposite.

In the centre illustration on the same plate an angler is shown by the side of an observation pond, with the wind rippling the surface of the water.

The third photograph illustrates how the image of this angler was masked by the ripple lines. This photograph was taken from a point two feet under the water at a distance of twenty-five feet. The white cross marks the position of the image of the angler. When the breeze dropped, the arc receded, and the angler stood up clearly above the observer.

Broken water has the same effect, and in rough water the image above the "window" disappears altogether. On the next plate are three illustrations—all of a fisherman in the same position, viz. seven feet distant from the observer under the water. The first photograph was taken in running water with the surface broken. In

Throwing a Line into Running Water.

1. Still Water. 2. Rippling Water. 3. Rough Water.

The Angler as seen from under the Water.

the second illustration the surface was definitely broken, and the figure is still discernible though it more resembles a bush than a man. In the last, where the water was flowing as a rapid broken stream, the figure of the angler is quite lost.

In each of these illustrations the fisherman was facing the observer at a distance of seven feet only. It is plainly seen, then, that when an angler is fishing upstream in rough water it is quite easy for him to get right over his fish without being detected.

Before I leave the consideration of the angler as seen from under the water, I will refer to the question of clothing.

All that I have written about the wading bird applies equally to the angler. If the clothing blends with the bushes, trees or buildings beyond, his image above the arc of the "window" is not easily detected, provided this image does not appear above the images of the scenery beyond. Bold "camouflage" patterns of clothing would be quite useful if an angler frequently fished in front of the same type of background. To illustrate how extremes of clothing can be successfully used I have illus-

trated the appearance of a man in a white coat.

In the top illustration on the plate opposite the fisherman was clad in a dark green Harris tweed suit. The sky was dull with white clouds.

The lower photograph shows the same angler with a white dust coat over his suit. Though his body is concealed the face and cap are still quite prominent.

A white cap and coat would be a rational fishing costume on the bank of a canal or in a boat on a loch. In the latter situation, however, I am afraid there might be trouble in convincing the gillie that the wearer was not qualifying for an asylum.

I will now describe the appearance of various lures as used with a rod. These are best considered under two headings: the lures which attempt to imitate the natural fly, whether fished dry or wet, and those which mainly depend upon "flash" for their attractiveness. The latter include captive live bait, spoons, spinners, the salmon fly, and wet trout flies, dressed with tinsel.

Most trout flies are tied with the intention of

1. Dressed in a Green Tweed Suit.
2. Wearing a White Dust Coat.

The Angler as seen from below the Water.

imitating some particular insect. I have already described the appearance of the dry fly. Under the water wet flies are seen in two ways. When the fly is well sunk it is seen against the rocks or vegetation on the bottom, or, at any rate, against the reflecting surface of the water. When fished near the top, it is seen with the bright light of the "window" as a background. In the former position its killing powers depend upon its form, colour and movement, whereas in the latter position the colour cannot be appreciated.

I will now describe the under-water appearance of lures that mainly depend upon "flash" to make them attractive. Most pike water swarm with roach and rudd. The live bait of the pike angler is only one among many thousands of fish in the water, and yet the pike is attracted to the captive bait. "Flash" is the explanation. The free fish in the water are swimming about on a level keel, and are rendered inconspicuous by reflecting their surroundings; in consequence, they do not arrest the attention of the pike. The captive bait, on the other hand, is constantly flashing in the water as it twists and turns in its endeavours

to escape. The pike is attracted, and seizes the roach on the snap tackle.

The spoon bait depends entirely upon "flash" to attract fish. Most spoons, as supplied by tackle makers, are made with far too extensive a flashing surface. Such spoons certainly attract the predatory pike or trout, but when the fish comes up to inspect, he follows for a time, and then falls back. The flash is unnatural and too bright.

I have used a spoon made in the following manner, so as to imitate as far as possible the appearance of a damaged or sick fish. The whole spoon is painted dark green except for a narrow strip of clear metal which runs diagonally across the convex side. This strip starts from a point at either end, and is not more than a quarter of an inch wide in the centre. The swivel ring is attached so that the spoon spins with a wobble. Seen from under the water, this spoon gives a quick flash, then a definite interval, followed by another quick flash. In 1912-13 I used the pattern described with considerable success.

My observations of the salmon fly, as it appears when presented to a fish, left me con-

vinced upon one point—viz. that the attraction of the salmon fly lies in the "flash." No one can realise the amount of "flash" from standard patterns until they have seen a "Jock Scott," a "Gordon," or a "Doctor" fished past them under the water. Colour is, I am sure, an unimportant factor in rendering the salmon fly attractive.

As an experiment, I should like to see the following tried: use a salmon fly of a standard shape tied in six sizes, and each size in three patterns, the same material to be used in each pattern, but varied solely from the point of more or less light-reflecting power. My brother and I tried this system with wet trout flies, but, unfortunately, the war cut our experiments short.

With our present patterns of flies, changing from one kind to another of exactly the same size will often result in killing fish; but these changes, when successful, are almost invariably from a quieter to a more gaudy pattern, or the reverse. A glance at a box of salmon flies will show what a change to a more gaudy pattern means—more tinsel on the body, often white eyes on a woodcock wing, and topping tag and

hackle made of good reflecting material, all of which points to the fact that it is the increased or diminished amount of "flash" which gives success.

The fact that many salmon rivers have their more favoured flies has been advanced in support of the value of colour in different patterns. I go further and say, every pool that has distinctive features—e.g. overhanging rocks or trees, or with flat, low-lying banks—has its more favoured pattern. This is not, however, dependent on its colour, but upon its light-reflecting power. The "flash" must be sufficient to attract the fish without causing it to refuse or come short when it follows up the fly.

The value of the feathers as feathers lies in their movement, which suggests that the fly is alive.

In almost every pool there is a particular spot where the salmon lie. Not infrequently that spot fishes best from, say, the right bank in the morning and the left bank in the evening. We can find an explanation for this in the "flash" of the fly and whether this "flash" is correctly timed as it passes the fish.

My point will be readily followed by an

inspection of the flies shown on the accompanying plate. Here we have four views of a "Gordon" as it passed in front of a fish. The fly has been thrown across the pool into the main light, and as it swings down with the light behind it, it is quite dull; but as the fly comes round, in front of the salmon, the light catches it, and there is a glint from body and hackle. The attention of the fish is arrested, and, as the fly swings still farther round, it flashes, as shown in the photographs on the left; the salmon follows up the flashing fly and seizes the hook.

Fished from the other bank, the fly would be flashing as it came up to the salmon; as it passed the fish it would become dull and disappear, and there would be no inducement to the fish to follow it up.

In these photographs I would draw attention to the fact that the eye on the woodcock wing flashes quite as brilliantly as the silver twist on the body.

Many wet trout flies are dressed with the intention of imitating a special natural fly. It is surprising to what extent many of these artificial flies flash. On the lower half of the

same plate there are three photographs of a "May fly." In the first illustration it is seen floating on the surface in the area of the "window"; the second shows it under the water; and the third illustrates a "flash" from the wing of the same fly.

"Flash" no doubt plays an important part in making many unconventional wet flies attractive. Many a time when the trout are off their feed an odd fish has been picked up on a "Butcher" fished deep. The trout has been unable to resist the flash of the silver body.

CHAPTER VIII

MISCELLANEOUS OBSERVATIONS

WITH the approach of autumn brown trout become restless, and the adult fish gradually make their way up tributaries or to the head waters of the river. Here, where the shallow stream ripples over the gravel beds, they deposit their ova. As soon as the spawning is completed the exhausted female drops down into the deeper water from which she came. The male, not infrequently, delays his return for a time, but ultimately reaches his usual haunts.

When they move up to spawn, a male trout may accompany the female fish on the journey until they reach suitable ground. On the other hand, he may not select his mate until the actual spawning grounds are reached. Here he is most attentive to her, jealously guards her against the attentions of other fish, and finally induces her to spawn.

Unless the male is an exceptionally large fish

he has to fight many a battle to retain possession of the trout of his selection. She, on her part, is indifferent, and should her lord be defeated, immediately accommodates herself to his successor. A stroll along the upper waters of a trout stream during the months of October or November will certainly give the observer an opportunity to witness a combat between two males. As a rule, the battle is not one decisive fight, but a series of skirmishes which continue throughout the day. On one occasion I was walking up a small stream when I heard violent splashing in the pool above; the sound was so loud that I thought a vigorous water-fowl was having a bath. But as I crept round the corner I came upon a trout fight. The fish were well matched, and it was one of the most determined struggles that I have ever witnessed. When first I saw them both fish were locked together and the surface of the water was covered with froth; after a time the exhausted combatants broke away, but it was not long before the aggressor had sufficiently recovered to renew the attack. This battle, with intervals of a few minutes, lasted for over an hour.

At one time a female and two male fish were

the sole survivors of six large rainbow trout turned into my observation pond. All went well until the spawning season came round. One of the males now attached himself to the female fish and drove off the other occupant of the pond whenever he came near. Every now and then the other male rainbow refused to go, and then a battle ensued. For three weeks these fish fought at intervals, but the trout that had first taken possession of the female was able to hold his own and retain his mate.

I have illustrated the last of these fights on the plate opposite page 154.

On this occasion I went down to the pond early one morning, to find the surface disturbed and covered with froth. From the observation chamber I watched the fish chase each other round and round in a gradually diminishing circle. This is shown in the top photograph. As I watched, the pursued fish suddenly turned and seized his pursuer by the jaw. After a rough and tumble, both broke away, like boxers in the ring, then they closed, and this time the trout that was ultimately victorious got an exceptionally good grip on the lower jaw of his opponent. They now turned over and over,

while the fish with a grip on the jaw at intervals shook his almost exhausted antagonist, like a terrier shakes a rat. He then let go and slowly swam away while the vanquished fish floated up to the surface. The dark shadows of small fry —the food of the trout—are seen scurrying off in the background of the photographs, and the white spots represent the floating foam. I netted the exhausted trout, swabbed his gills with a piece of cotton wool soaked in whisky, and then held him in running water with his head upstream; when he revived he was placed in another pond.

The victorious male now became very attentive to his mate, and in a few days she spawned. Fortunately she commenced operations at a distance of not more than two feet from the window of the observation chamber. First, she turned on her side and flapped out a hollow or trench in the gravel with her tail. During her exertions the eggs, or hard roe, escaped from her into the hollow which she had made. The male, meanwhile, was near by, and as he shed his milt, or soft roe, into the water, many of the eggs were fertilised. The female fish next moved a few inches forward and flapped out another

hollow. The gravel from this was automatically thrown back and covered the eggs in the first hollow.

The process was repeated until about one thousand fertilised eggs were buried two to four inches below the gravel, over an area of several feet. Spawning as described was continued for two days.

I should have liked to have watched the eggs hatch, but the pond was required for further fish observation. When it was cleaned out, for this purpose, I examined the eggs and found that about fifty per cent. had been fertilised.

During the time that trout were under observation in my ponds, there was some correspondence in *The Fishing Gazette* as to the manner in which trout approached their food. It was stated that a feeding fish invariably came at its food open-mouthed. This is true provided the trout is some distance off and has made up its mind to take the food before he starts towards it.

When a fish is steadily feeding near the surface, the mouth is not opened until the snout nearly touches the fly. As soon as the mouth is opened the gill covers are raised from the side

of the head. This causes a suck, and the fly is carried down into the mouth of the trout.

When the fish is a foot or two below the surface, he behaves in two ways. He may come up to inspect the fly before he takes it, in which case he feeds as described. On the other hand, the trout may make up his mind that he will have the fly before he starts. Under these circumstances he rushes at it open-mouthed. When a fish feeds in this manner there is often a loud splash, and the fly is missed, because it is knocked out of the way. When food is taken under the water, the gorged fish may come leisurely towards it, but the feeding fish rushes at it with open mouth. The mouth of a trout in these circumstances is often open when the fish is still two to three feet from the food.

On the plate opposite are three photographs. In the top one, the trout has detected food, and is giving a lateral swish with its tail to drive him through the water. In the two lower illustrations the same fish is shown moving rapidly forwards with the mouth open.

When these photographs were taken the food was thrown into the water about six feet in front of the trout, and the mouth was invariably open

A Rainbow Trout rushing at Food with Open Mouth.

when the fish was at least two to three feet away from its objective.

In cases where food is taken on the bottom, the trout does not go straight down upon it like a roach, but partly rolls over and picks it up with the side of his mouth. This half turn of the body gives the "flash," as illustrated in the photograph of a feeding trout opposite page 18.

A trout seizes a worm by any part of it, whether he takes it leisurely or whether he rushes at it. If the worm is seized near the end, the fish frequently spits it out, to seize it again nearer the middle. When hungry, the fish cares for little except to get the worm down, and swallows it right away. After feeding for a time, he frequently takes the food into the mouth, bites it, and spits it out again, and this is repeated two or three times before the worm is swallowed.

When a trout spits out a worm, it is ejected some distance, and this is often an opportunity for another fish to rush up and seize it. At other times the worm is chewed for two or three minutes before it is swallowed, and the trout appears to get pleasure from the taste.

Members of the carp family, e.g. carp, roach

and rudd, invariably seize a worm by one end or the other.

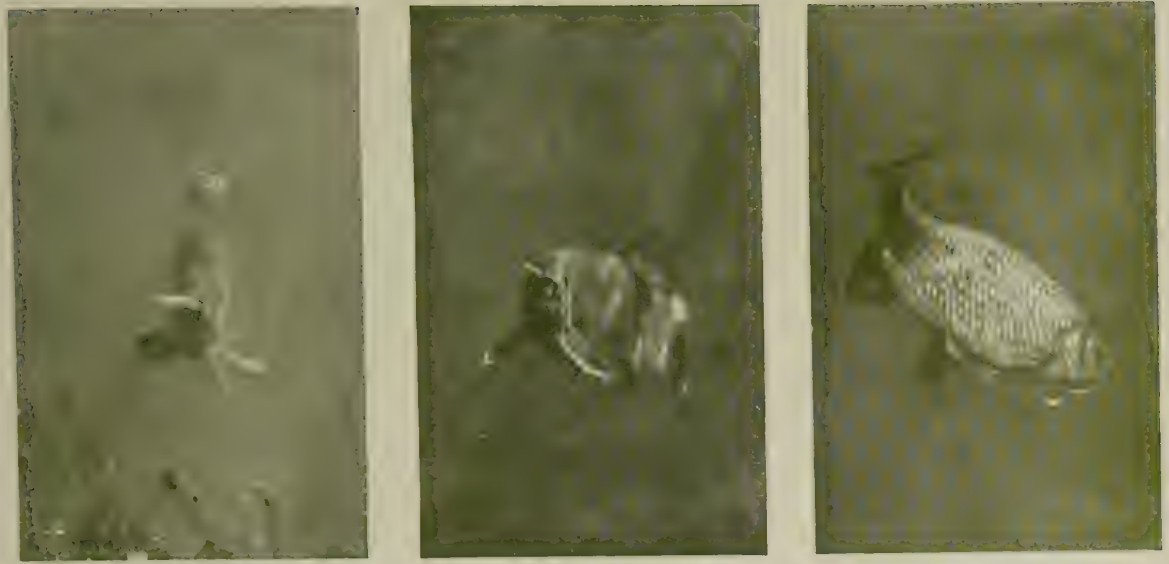
On the plate opposite a rudd, three-quarters of a pound in weight, is shown taking a worm. Even a small worm, as shown in the middle illustration, was invariably seized by the end. Only on one occasion did I see this fish take a worm by the middle, and then he spat it out and took it again by the end.

Perch, as a rule, deliberate more than most fish before they feed, but once they have made up their minds they rush at their food.

There is, however, no hard-and-fast rule as to the feeding methods of any particular fish, and with altered conditions a fish will very rapidly change its methods of feeding. This is illustrated by the behaviour of a tench which inhabited the pond at the same time as several trout.

The fish in the pond were frequently fed on mealworms. When lightly thrown on the water, mealworms float for a few seconds, and then slowly sink. The trout rushed at them immediately they touched the water, and no food ever sank far below the surface.

The tench is essentially a bottom feeder, and



Rudd taking a Worm.

in consequence went hungry. The fish in question, however, very soon altered its usual habits of feeding and came up to the surface with the trout. Here the slow-moving tench was able to suck down a few of the floating worms before the more active trout devoured them all.

These different ways in which fish take a worm have a bearing upon the manner in which they should be offered worms as bait. I have shown how a trout seizes any part of the worm. Here we have an explanation as to why "Stewart" tackle is so much more effective than a single hook when the running worm is used for trout. Further, when fishing for carp, bream, roach, rudd, etc., it is obviously wrong to put a hook through the middle of the worm with the ends free.

I have fished successfully for carp with a small hook at each end of the worm. My method is as follows: At each end of a short length of gut tie a hook—the hooks are usually about three inches apart when the tackle is complete; in the middle of this gut attach a trace at right angles. To bait, start at the middle of the worm, and thread each hook outwards. Previous to threading the worm with the hooks, it can be

thrown forcibly on the ground and killed. The worm now lies on the bottom with the gut trace coming out at right angles from the middle, and the head and tail each contains a hook threaded to the end.

As the carp family invariably take one end of the worm the angler can be certain that the hook is in the fish's mouth as soon as the float moves, and can strike at once. The advantage in being able to strike at once, instead of waiting until the fish *has had time to take the worm*, is obvious. How often when fishing for carp has the float just gone under and then come up again? The carp has taken the end of the worm into his mouth preparatory to *sucking* it down, but the timid fish has felt a check on the captive worm, or its suspicions have been aroused in some other manner, and the bait is rejected before the hook has even been near the mouth of the fish.

While brown trout (*salmo fario*) were under observation in my ponds I was very much struck with the sudden change in their appearance when these fish were alarmed. Like all other fish, trout, by reflection, appear dark or light, red, green, or any other colour, according to the

nature of their surroundings. In addition, trout show certain "fear markings" which are not dependent upon light. When a trout is alarmed it rushes off to hide itself in some dark corner. Should this dark corner be available, the fish is soon lost to sight, but if the fish has to take shelter in light surroundings, the body of the trout reflects the colour around, except for a dark band down each side of the body and four irregular prolongations from this band towards the back. These dark markings give the fish a blotchy appearance, which are well illustrated in the colour photograph of the common brown trout which serves as the frontispiece to this volume.

If the alarmed trout is further disturbed, it will dash away, and as it rushes through the water the fish has a distinctly barred appearance. After swimming about for a few minutes, these dark marks disappear, and the fish becomes a uniform shade. When the trout comes to rest it is still of a uniform shade, but, if again alarmed, the blotchy appearance will return within a few seconds. The barred appearance of the fish as it swims away has no connection with the primitive parr marks of the trout.

There are bullies in the fish world, as in all other walks of life, and most pools have one fish who is cock o' the walk.

In the spring of 1911 six rainbow trout were placed in a pond. By the end of the summer one of the fish weighed over a pound, and was considerably heavier than the others. The larger size of this fish was explained by the fact that he seized most of the food. He was the absolute master of the situation, and spent a considerable part of the day chasing and biting his smaller brethren.

In September three chub, each weighing over two pounds, were added to the occupants of the pond. The rainbow immediately attacked them. The chub were sluggish and were not accustomed to being bullied. At first they could not understand what was required of them when the trout butted and bit them in the back and tail. Within a week, however, the rainbow trout had struck terror into their hearts, and he would spend hours chasing them round the pond. Two chub are shown on the plate opposite as they passed the window of the observation chamber. These fish were escaping while the rainbow attacked the third. The bully of the

pond was not content to chase the chub away from their food, but would hustle them round apparently out of pure devilment.

"Every dog has his day," and I dealt with that bullying rainbow by adding still another fish to the pond—namely, a three-pound pike. The effect was magical, and whenever the bullying rainbow came across the pike he sank down and lay still on the bottom of the pond. The pike was not large enough to hurt the other fish, and for a time comparative peace reigned in the pond.

Shortly before I was obliged to cease observations upon my ponds I had commenced to watch the habits of swans and ducks with regard to their influence on fish life.

Swans certainly strip the spawn of coarse fish and the ribbons of perch ova from submerged roots and vegetation, but I have not myself come across an instance of swans disturbing the buried ova of trout, as they are stated to do.

The scope of the non-diving ducks is so limited that the harm they do must be negligible. When, however, fish spawn is within the reach of a surface-swimming duck it certainly clears off every egg.

A friend of mine near Ipswich had wild ducks on his farm, and he kindly lent me a pair, which nested on the bank of the observation pond in my garden. The moat at Playford Hall, near by, was full of roach, and these fish attached their eggs to the submerged rootlets of willows which grew all round the moat. I placed several of the rootlets some six inches under the water in my pond, and watched the wild duck strip off the eggs. Their methods were very thorough, for after they had finished not an egg remained.

Diving ducks, on the other hand, do not confine their attention to ova, and the merganser and the goosander take large quantities of small fish. I once examined four mergansers on the estuary of the River Ore. These birds contained as many as fifty small fish apiece. I quote from Seton Gordon their influence on trout and salmon waters:

"It is only recently that the name of the goosander has been withdrawn from the list of protected birds in a certain county on account of the number of young trout and salmon he devours, and an experience I had a few days ago would seem to go far to confirm the unfortunate reputation he has gained. On an expedition

A Young Pike on the Look-out.

from the Forest of Gaick eastwards we descended to a certain hill burn near its source, and followed it for a number of miles. At first the burn was literally swarming with trout up to one pound and more in weight, but gradually their numbers decreased, and we disturbed a couple of goosanders in their fishing operations. There were ample signs that they had taken up their home in the district, and near where we noted them there was scarcely a single fish in the burn. Especially when they have young the goosander must account for a very large number of trout, and it is not unnatural that the salmon-fisher should hold none too friendly feelings towards this bird. Not so many years ago the River Dee, near its source, held great numbers of small trout, but I was assured by a veteran stalker that these trout were almost entirely wiped out during a season by a pair of goosanders which took up their residence in the district, and after my recent experience I am obliged to alter my previous conviction that the account I heard was an exaggerated one."

When an animal or bird is constantly observed in captivity there is a tendency for a

familiarity to grow up between the particular specimen under consideration and the observer. This is a drawback, because the attitudes and habits caused by natural fear of a wild animal cannot be watched. I have, therefore, endeavoured to remain concealed as far as possible during my observations. One of the best methods of obtaining this concealment is to make a home for the specimen to be observed in an empty observation pond, and watch it through the glass of the chamber. Under these conditions, with the lid of the chamber closed, the observer is neither heard nor smelt.

In some instances it has been necessary to tame the subject in order to obtain some particular photographic record—e.g. the colour plates of the water-hen shown in the introductory chapter. This bird became so tame that it would come off the water as soon as I appeared and demand food. It required a considerable amount of exertion upon the part of my man to drive her under the water when I wished to demonstrate her subaqueous flight. This is illustrated on the plate opposite.

A water-hen propels itself under the water in two ways. The bird usually makes three or

Water-hen Flying under the Water.

four strokes with the wings; these are then closed and pressed tightly to the sides, and the bird shoots forward with the legs trailing behind. After travelling about two feet the flight is repeated. On other occasions, when not hurried, it appears to walk in the water with a high-stepping action.

After five years disuse my ponds no longer exist. The observation pond in the garden of the old house at Ipswich has been partially filled up, and grows water-lilies. The pond by the Corporation waterworks was destroyed in case a German spy should hide in the observation chamber; and the wooden tank on the controlled stream has fallen in, and the plate-glass has been sold for the benefit of a local charity. I shall probably make another observation pond when labour and the cost of material have become normal. In case, however, any of my readers should feel inclined to make a pond and observe for themselves some of the appearances I have recorded, I will describe the most economical method of constructing a pond for general observation.

Do not attempt a pond unless a plentiful

water supply is obtainable. The general principle, as shown on the bottom half of the plate opposite page 8, is the best. The observation chamber consists of a large wooden water-tight box, with a plate-glass window in one side, and a lid that fits over the top. This box is let into the side of a small stream, and the pond formed by holding up the water below with a bank or wall. In the bottom of this bank or wall there should be a six-inch pipe, so that the water may be run off easily when it is desired to clean or alter the pond. Given a suitable position, the cost of such an arrangement before the war was about £15 to £20.

I have always been interested in fish life, and originally built an observation pond so as to be able to take photographs of fish illuminated as in Nature. The results were fully described in "Marvels of Fish Life," published by Cassell and Co. in 1911.

My observations gradually led to the investigation of the destruction of fish by their natural enemies, particularly in the case of the fresh-water fish of our rivers and inland waters.

Inland waters well stocked with good-sized fish are rapidly becoming scarcer, and good free

fishing is almost a thing of the past. This is certainly not due to the fact that there are now many more anglers who fish with rod and line, for fair fishing will never deplete waters. The explanation is found in one word: *Pollution*. For this the Fishery Board is largely responsible; local protests, instead of meeting with instant support and remedy on the part of the Board, form the matter of unending "inquiries" and "reports," without anything practical being achieved. Even where stringent regulations do exist as to pollution, all the fish in a river have frequently been poisoned by the carelessness of manufacturers who have allowed poisoned tanks, etc., to overflow. These manufacturers are often wealthy firms, and either get off free or with totally inadequate fines. What is there left to do by the individual interested in the general preservation of fish on our inland waters? As man has upset the balance by his methods, all that remains is to restore it as far as possible in waters still unpolluted by waging continuous war against the enemies of the fish.

I have indicated the influence of the otter, divers, the heron, gulls, etc., on fish life, and particularly on the existence of trout. The

biased bird protectionist will, on principle, not agree. There are many individuals, however, who, though willing to give the fish in our inland waters fair play, do not agree to the destruction of their natural enemies because they are told certain species will become extinct. The heron is safe on the fens and marshes; the diver can always elude man at sea; gulls breed beyond our reach. If the systematic destruction of fish-feeding birds were carried out for some years it is possible that their numbers might be reduced. This is what is required to give the fish in our inland waters a fair chance.

Index

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